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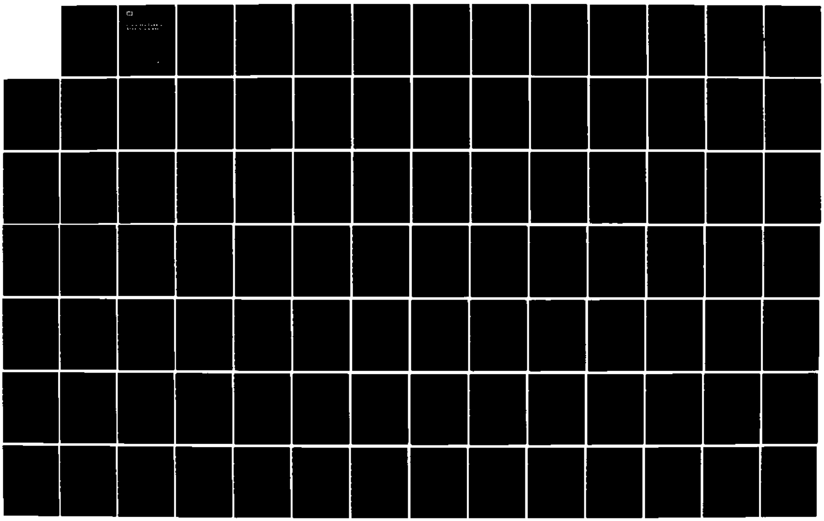

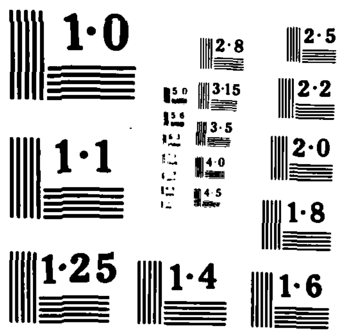
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US Army Corps
of Engineers
New Orleans District

Louisiana Coastal Area, Louisiana

Freshwater Diversion to Barataria and Breton Sound Basins

Feasibility Study

Volume 2
Technical Appendixes
A, B, C, D

September 1984

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The Barataria and Breton Sound Basins have experienced rapid loss of coastal wetlands due to natural processes such as subsidence and erosion, as well as man's developmental activities including leveeing, channelization, and petroleum exploration. These activities have led to a reduction in overbank flooding and natural distributary flow which historically provided fresh water, sediments, and nutrients to estuarine areas. This has resulted in conversion of fresh, intermediate, and brackish marshes to intermediate, brackish, and

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20. ABSTRACT (CONTINUED)

saline marshes, respectively, as well as loss of some areas of wooded swamp. Saltwater intrusion and loss of wetlands have adversely affected productivity of wildlife and fishery resources. Influx of saline waters is particularly harmful to the American oyster, due to increased predation. One way to ameliorate loss of wetland nursery areas and rate of saltwater intrusion is timely introduction of fresh water and associated sediments and nutrients. A total of 16 plans were evaluated for diversion of fresh water into the study area. These 16 plans consist basically of combinations of six freshwater diversion sites and various magnitudes of flow. Based on the results of this study, it has been recommended that fresh water from the Mississippi River be diverted into the Barataria Basin at a site near Davis Pond (river mile 118.4) and into the Breton Sound Basin at Big Mar (river mile 81.5).

APPENDIX A

PROBLEM IDENTIFICATION

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Interim Report on Freshwater Diversion

to

Barataria and Breton Sound Basins

Appendix A

P R O B L E M   I D E N T I F I C A T I O N

A.0.1. The Problem Identification Appendix provides the study authority for the Interim Report on Freshwater Diversion to the Barataria and Breton Sound Basins. Prior studies and reports by the U. S. Army Corps of Engineers (USACE) and others that encompass the study area or portions of the area are included. Existing conditions of the land, water, biological, cultural, recreation, and human resources are described. The demography, economy, and land use of the area are described. The area's resources and economy are projected into the future to determine conditions if no Federal action is taken. Water and related land resource problems, needs, and opportunities are identified and planning objectives are developed for the study. Planning constraints affecting the study are established.

Section 1. STUDY AUTHORITY AND SCOPE

A.1.1. The Louisiana Coastal Area Study was authorized by resolutions of the Committee on Public Works of the U. S. Senate and House of Representatives. The Senate resolution, sponsored by the late Senator Allen J. Ellender and Senator Russell B. Long and adopted 19 April 1967, reads:

> "RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, That the Board of Engineers for Rivers and Harbors created under Section 3 of the River and Harbor Act approved June 13, 1902, be, and is hereby requested to review the reports of the Chief of Engineers on the Mermentau River and Tributaries and Gulf Intracoastal Waterway and connecting waters, Louisiana, published as Senate Document Numbered 231, Seventy-ninth Congress, on the Bayou Teche, Teche-Vermilion Waterway and Vermilion River, Louisiana, published as Senate Document Numbered 93, Seventy-seventh Congress, on the Calcasieu River salt water barrier, Louisiana, published as House Document Numbered 582, Eighty-seventh Congress, and on Bayous Terrebonne, Petit Caillou, Grand Caillou, DuLarge, and connecting channels, Louisiana, and the Atchafalaya River, Morgan City to the Gulf of Mexico, published as House Document Numbered 583, Eighty-seventh Congress, and other pertinent reports including that on Bayou Lafourche and Lafourche-Jump Waterway, Louisiana, published as House Document Numbered 112, Eighty-sixth Congress, with a view to determining the advisability of improvements or modifications to existing improvements in the coastal area of Louisiana in the interest of hurricane protection, prevention of salt water intrusion, preservation of fish and wildlife, prevention of erosion, and related water resource purposes."

A.1.2. The U. S. House Committee on Public Works adopted an identical resolution on 19 October 1967. Sponsors were US Representatives Edwin Edwards, Speedy O. Long, John R. Rarick, Joe D. Waggoner, Edwin E. Willis, and the late F. Edward Hebert, Hale Boggs, and Otto E. Passman.

A.1.3. Under the Louisiana Coastal Area Study, an interim report on freshwater diversion was approved by 3d indorsement, file LMVPD-P, dated 17 December 1980, to letter file, LMNPD-P, dated 29 May 1980, subject "Louisiana Coastal Area Study."

A.1.4. The primary focus of the study was on increasing productivity of commercial fishery resources through diversion of freshwater in the study area. Concomitant opportunities and problems related to sport fishing and hunting, commercial trapping, outdoor recreation, preservation of cultural resources, and preservation and enhancement of environmentally unique and sensitive areas were analyzed in the study. The study area is about 2.3 million acres and includes the area that would be inundated by the Standard Project Hurricane with all authorized USACE works in place, that is, approximately lands up to the 5-foot contour. (See plate A-1)

SECTION 2. PRIOR STUDIES, REPORTS, AND EXISTING WATER PROJECTS

A.2.1. Numerous studies and reports concerning water resources development in the coastal area of Louisiana have been prepared by the USACE, other Federal and state agencies, and individuals. Only the major reports on projects pertinent to the present study are described below.

A.2.2. A review of the Mississippi River and Tributaries project, prepared by the New Orleans District and printed as House Document No. 308, 89th Congress, 1st Session, recommended the construction of four salinity control structures for introducing water from the Mississippi River into the marshes of the Mississippi Delta Region. The structures are Myrtle Grove (river mile 58.7), Homeplace (river mile 37.0), Bohemia (river mile 43.0), and Caernarvon (river mile 81.5). The project was authorized by the Flood Control Act of 1965. Advanced engineering and design was initiated in 1969 on the structure located at Bohemia, but was suspended at the request of local interests. The four sites were reevaluated in the current study.

A.2.3. A study of fish and wildlife in the Louisiana coastal area and Atchafalaya basin floodway was conducted by the New Orleans District in support of the Louisiana Coastal Area study, West Texas and Eastern New Mexico Water Import study (Mississippi River Commission, 1973), Lower Mississippi Region Comprehensive study (Lower Mississippi Region Comprehensive study, Coordinating Committee, 1974), Atchafalaya Basin (Water and Land Resources) study (U. S. Army Corps of Engineers, 1981, Draft), and National Shoreline study (U. S. Army Corps of Engineers, 1971). The study includes a preliminary determination of the cyclic quantities of supplemental freshwater needed to optimize productivity of the fish and wildlife resources and possible options for supplying this water for each estuarine area including Lakes Maurepas, Pontchartrain, and Borgne. Special studies and investigations undertaken to obtain

A.3.8. In addition to the licensed commercial shrimpers, there are a large number of licensed and unlicensed sport shrimpers. Shrimpers who do not intend to sell their catch are not required to license their vessels or any trawls under 16 feet in length, but their catch is limited to 100 pounds of "heads-on" shrimp per day per boat. However, sport shrimpers who want to exceed the 100 pound limit or use trawls over 16 feet in length must purchase a noncommercial license. In 1980, nearly 6,000 noncommercial licenses were sold in the area, about 55 percent of the total for the state. Jefferson, Terrebonne, and Lafourche Parishes were again leaders in this category. The estimated number of unlicensed sport shrimpers is three times the number of licensed recreational shrimpers. For the study area, this difference would amount to an additional 18,000 shrimpers.

A.3.9. There were 1,200 oyster licenses and slightly over 500 blue crab licenses issued in 1980. In addition, 3,100 licenses were issued for trapping. However, over 1,000 fishermen held various combinations of fishing licenses, primarily both commercial shrimping and oyster dredging licenses. Some also fish in combination with trapping and taking alligators.

A.3.10. There were 242 fishery processing and wholesaling plants in Louisiana in 1979 that provided nearly 3,500 permanent jobs while also employing several thousand part-time workers during peak seasons. A good portion of these plants are located in the study area.

A.3.11. In summary, there appear to be about 3,000 fulltime commercial fishermen in the study area plus another 10,000 fishermen who work commercially only part-time. There are also approximately 90,000 licensed recreational fishermen. Total licenses issued in the area nearly doubled between 1970-1980.

people. The Agricultural, Forestries, and Fisheries sector had less than 1 percent of the area total employment in 1978, according to the Bureau of the Census. Employment in the fishing industry is not separately categorized by the census. However, the fisheries industry is a much more important source of employment and income for the area than would appear from the census breakdown. The industry is marked by the very large number of commercial part-time and noncommercial licensed and unlicensed sport shrimp fishermen who have other primary sources of employment.

A.3.6. The most useful published sources of detailed information concerning participation in the fisheries sector are the licensing records of the Louisiana Department of Wildlife and Fisheries. In 1970, 9,100 commercial licenses were issued to commercial fishermen and noncommercial fishermen who were required to be licensed due to their use of commercial size trawls. The number of licenses issued increased steadily during the 1970's and by 1980, 22,877 were issued. The majority of all license issued were for shrimp fishing, either commercial or noncommercial.

A.3.7. In Louisiana, anyone who intends to sell his shrimp catch is considered to be a commercial fisherman and must purchase a commercial shrimp license. In 1980, there were about 11,000 commercial shrimp licenses issued in the area, which included licenses for both small boats and large vessels. The licenses issued amounted to about two-thirds of the total issued for the state. Jefferson, Terrebonne, and Lafourche Parishes were ranked first, second, and third in this category, respectively. These commercially licensed shrimpers operated nearly 10,000 registered small boats and 1,000 large vessels in 1980. It was estimated that nearly 90 percent of those licensed boat shrimpers had other jobs besides shrimping. Therefore, a large number of commercially licensed boat shrimpers are clearly part-time shrimpers.

TABLE A-3-2

TOTAL EMPLOYMENT BY PARISH

	1970	1978
New Orleans SMSA[1/]	450,000	545,400
Ascension	10 300	18,100
Assumption	5,000	7,500
Lafourche	20,400	28,100
Plaquemines	11,900	17,200
St. Charles	9,400	17,600
St. James	5,900	7,800
St. John the Baptist	4,700	7,300
Study Area	544,700	691,300
Louisiana	1,365,300	1,728,300

SOURCE: The Louisiana Economy, Louisiana Tech University, Research Division, Volume XIII, No. 4, May 1980.

1/ Includes Orleans, Jefferson, St. Bernard, and St. Tammany Parishes.

PER CAPITA INCOME

A.3.3. Of the 12 parishes in the area, it is estimated that only four had a per capita income below the state average in 1980 compared with over half in 1970. Plaquemines, St. James, and Terrebonne Parishes were below the state average in 1970, but above in 1980. State per capita income was $7,900 (1981 dollars) in 1970 and an estimated $9,500 (1981 dollors) in 1980, which represents a real average growth rate of about 1.9 percent annually. Except for the New Orleans SMSA, all parishes in the area had per capita income growth rates in excess of the average for the state. Plaquemines Parish had the highest annual growth rate of 7.6 percent, followed by Assumption (6.7 percent) and Lafourche (6.4 percent). In the New Orleans SMSA, the per capita income grew from $8,900 in 1970 to $10,300 in 1980, an average annual growth rate of 1.5 percent. Table A-3-1 shows the per capita income for the 12-parish area for 1970 and 1980.

EMPLOYMENT

A.3.4. Table A-3-2 shows total employment in the area in 1970 and 1978. In 1978, employment by place of work was approximately 691,300, an increase of 27 percent over the 1970 employment of 544,700, which is a growth rate slightly greater than that for the state as a whole. St. Charles and Ascension Parishes ranked first and second in the state in the percent increase in employment between 1970 and 1978, 87 percent and 75 percent, respectively. Employment in the New Orleans SMSA grew at the slowest overall rate, 21 percent. However, the New Orleans SMSA provided well over half of the new jobs available in the area over the period 1970-1978.

A.3.5. The largest source of jobs in the area in 1978 was in the Retail and Wholesale Trade sector which employed nearly 150,000 people. The Service and the Government sectors each provided work for over 100,000

TABLE A-3-1

POPULATION AND PER CAPITA INCOME

	1970		1980	
	Population	Per Capita Income 1/	Population	Per Capita Income 1/
New Orleans SMSA 2/	1,046,500	$8,900	1,186,700	$10,300
Ascension	37,100	6,700	50,100	8,800
Assumption	19,700	4,300	22,100	8,200
Lafourche	68,900	5,100	82,500	9,500
Plaquemines	25,200	4,600	26,000	9,600
St. Charles	29,600	8,100	37,300	10,100
St. James	19,700	7,300	21,500	9,800
St. John the Baptist	23,800	5,200	31,900	8,700
Terrebonne	76,000	7,100	94,400	10,600
Economic Study Area	1,346,500	--	1,552,500	--
Louisiana	3,644,600	7,900	4,204,000	9,500

SOURCE: Population. 1970: The Louisiana Economy, Vol. XIII, No. 4, May 1980, Louisiana Tech University, Research Division. 1980: Compiled by State Planning Office, State Data Center, from information received from the U. S. Census Bureau, Dallas Regional Office, December 1980.

Income. Survey of Current Business, Vol. 58, No. 6, June 1978, and Vol. 60, No. 4, April 1980, Per Capita Personal Income, U. S. Department of Commerce, Bureau of the Census. The 1980 per capita income figures were derived by interpolating between the 1978 data and the 1985 projected data extracted from the 1980 OBERS BEA Regional Projections.

1/ 1981 dollars.
2/ Includes Orleans, Jefferson, St. Tammany, and St. Bernard Parishes.

Section 3. EXISTING CONDITIONS

HUMAN RESOURCES AND ECONOMY

A.3.1. In compiling statistical data for the Human Resources and Economy Section, three parishes outside the study area and eight parishes extending into the study area proper were included because they are economically significant to the study area. The only parish totally within the study area is Plaquemines. The three outside the area are Ascension, St. Tammany, and Terrebonne, and the eight parishes partially included are Assumption, Jefferson, Lafourche, Orleans, St. Bernard, St. Charles, St. James, and St. John the Baptist. Numerous residents of these parishes work and recreate in the study area and contribute extensively to the economy. Residents of these parishes heavily utilize the study area resources for hunting and fishing and general outdoor recreation activities. Together, these 12 parishes form the economic area.

POPULATION CHARACTERISTICS

A.3.2. The 1980 population of the study area is estimated at 282,600, which represents 18 percent of the population of the economic area. The population of the economic area in 1980 was 1,552,500. This was an increase of 206,000 or about 15 percent from the 1970 population of 1,346,500. Louisiana's population during this period increased by about the same percent. Table A-3-1 shows the population change over the last decade for the 12-parish economic area. The 1980 population made up 37 percent of the total state population for that year. The New Orleans Standard Metropolitan Statistical Area (SMSA) along with Assumption, Plaquemines, and St. James Parishes grew at a slower rate than the state as a whole, while the rest of the parishes in the study area grew faster. The New Orleans SMSA, which consists of Orleans, Jefferson, St. Tammany, and St. Bernard Parishes, had a population of 1,186,700 in 1980, which was over 76 percent of the total study area population and an increase of 13 percent over the 1970 metropolitan area population.

A.2.17. The Louisiana Department of Public Works constructed a freshwater diversion structure on the east bank of the Mississippi River at Bayou Lamoque in the Pointe-a-la-Hache Relief Outlet in 1955. This structure consists of four 10- by 10-foot gated conduits for diverting freshwater from the river through an improved Bayou Lamoque to reduce salinity concentrations on the oyster beds in the bays east of the river.

A.2.18. A freshwater diversion structure has been constructed by Plaquemines Parish on the east bank of the Mississippi River at Little Coquille. This structure, used for diverting freshwater to bays east of the river, consists of five 48-inch concrete culverts with provisions to regulate flow.

A.2.19. In 1970, the Louisiana Department of Public Works completed construction of a freshwater diversion structure on the east bank of the Mississippi River at Bohemia. This structure consists of four 60-inch gated conduits and is used for diverting freshwater to bays east of the river.

A.2.20. In 1977, the Louisiana Department of Public Works completed construction of a second freshwater diversion structure on the east bank of the Mississippi River at Bayou Lamoque just downstream of the existing structure. This structure consists of four 121- by 12-foot gated outlets.

A.2.21. A diversion structure was completed at White's Ditch in 1956. The purpose of the structure was to provide freshwater to the river Aux Chenes area. The diversion of freshwater to the area has restored the area to fresh marsh suitable for ducks and furbearers.

55-foot navigable depth. The report was approved by the Board of Engineers for Rivers and Harbors in March 1982, and by the Chief of Engineers (OCE) in April 1983. The report is being reviewed by the Office of the Secretary of the Army. Continuing planning and engineering studies were initiated in fiscal year 1982. A general design memorandum on dredging in the Mississippi River, Venice to the gulf was completed in August 1983 and approved by OCE in March 1984. A general design memorandum on dredging the Mississippi River between mile 173 and Venice is scheduled for completion in August 1985. A final design memorandum is currently underway.

A.2.14. The report, "Barataria Bay Waterway, Louisiana," was published as House Document 82, 85th Congress, 1st Session. The project provides for a channel approximately 37.0 miles long with a 12-foot depth and a 125-foot width, beginning at the GIWW to Grand Isle, Louisiana. These improvements were authorized by the River and Harbor Act of 3 July 1958. Enlargement of the entrance channel between mile 0.0 and the -15 foot contour in the gulf to 15- by 250-feet was approved in January 1978. All work has been completed.

A.2.15. The Orleans Levee District, with Federal approval, constructed the Pointe-a-la-Hache Relief Outlet in the 1920's. The project is located on the east bank of the Mississippi River below Bohemia and provides for the discharge of floodwaters directly into Breton Sound as a relief outlet for the benefit of the city of New Orleans. The outlet passed some 300,000 cfs during the 1927 flood but has shoaled in the intervening years to a much lower capacity.

A.2.16. The Louisiana Department of Public Works has constructed a lock through the Mississippi River non-Federal levee at Ostrica. The lock is located on the east bank at about river mile 25.0. The lock is 40 feet wide, 250 feet long, and has a sill elevation of -10.0 feet National Geodetic Vertical Datum (NGVD). The lock is extensively used by oilfield and fishing vessels.

A.2.11. The project, "Gulf Intracoastal Waterway Between Apalachee Bay, Florida, and the Mexican Border," authorized by the River and Harbor Act of 1962 and numerous prior river and harbor acts, provides generally for the following improvements within the study area: a 16- by 150-foot channel between the Mississippi and Atchafalaya Rivers via a lock through the west Mississippi River levee at mile 98 above Head of Passes (AHP) at Harvey, Louisiana, an alternate 16- by 150-foot channel connecting the above channel and the Mississippi River via a lock through the west Mississippi River levee at mile 88 AHP in Algiers, Louisiana, a 12- by 125-foot channel connecting the Gulf Intracoastal Waterway (GIWW) at Morgan City, Louisiana, and the Mississippi River at Port Allen, Louisiana, via a lock through the levee at Mississippi River, mile 228 AHP, a 12- by 150-foot channel between the Rigolets (between Lakes Borgne and Pontchartrain) and the Mississippi River via a portion of the IHNC and lock at mile 93 AHP, and annual payments to the Board of Commissioners of the Port of New Orleans for use of a portion of the IHNC and for use of the lock. The 16- by 150-foot channel has not been constructed.

A.2.12. The report, "Mississippi River for Additional Navigation Outlets in the Vicinity of Venice, Louisiana," published as House Document 361, 90th Congress, resulted in the authorization of additional navigational outlets from the Mississippi River in the vicinity of Venice, Louisiana, by enlargement of the existing channels of Baptiste Collette Bayou and Grand Tiger Passes to provide channels 14 feet deep (mean low gulf) over a bottom width of 150 feet, with entrance channels in open water 16 feet deep over a bottom width of 250 feet. All work has been completed. Jetties to the 6-foot depth contour are authorized if and when justified to reduce the cost of maintenance dredging.

A.2.13. The report, "Deep Draft Access to the Ports of New Orleans and Baton Rouge, Louisiana", published in July 1981, recommended deepening the Mississippi River between Baton Rouge and the Gulf of Mexico to a

single project, "Mississippi River, Baton Rouge to the Gulf of Mexico, Louisiana," with modification to provide the following channel dimensions. All works were completed.

Mississippi River:

Baton Rouge to New Orleans: 35 by 500 feet
Port of New Orleans: 35 by 1,500 feet
New Orleans to Head of Passes: 40 by 1,000 feet
Southwest Pass: 40 by 800 feet
Southwest Pass Bar Channel: 40 by 600 feet
South Pass: 30 by 450 feet
South Pass Bar Channel: 30 by 600 feet

A.2.9. The report, "Mississippi River-Gulf Outlet," published as House Document No. 245, 82nd Congress, resulted in the authorization, under the River and Harbor Act of 1956, of a project providing for a 36- by 500-foot ship channel between the Inner Harbor Navigation Canal (IHNC) in New Orleans and the Gulf of Mexico, Louisiana, a 1,000- by 2,000- by 36-foot turning basin at its junction with the IHNC, and a new high level bridge over the channel at Louisiana Highway 47. This authorization provides for a lock and connecting channel between the Mississippi River and the new ship channel when economically justified by obsolescence of the existing IHNC lock or by increased traffic. All work has been completed except the lock, connecting channel, and the new ship channel.

A.2.10. The report, "Mississippi River, Baton Rouge to the Gulf of Mexico, Louisiana," published as Senate Document No. 36, 87th Congress, resulted in the authorization, by the River and Harbor Act of 1962, of the modification of the existing project to provide a 40- by 500-foot channel in the Mississippi River from the lower limits of the Port of New Orleans adjacent to the existing 35- by 1,500-foot channel through the port and thence to Baton Rouge, Louisiana. All work has been completed.

Report No. 5	Salinity and Temperature Atlas of Louisiana Estuaries
Report No. 6	Seasonal Precipitation Surplus and Annual Precipitation Deficit Maps of South Louisiana, 1945-1968
Report No. 7	Louisiana Wildlife and Fisheries Water Chemistry Survey Data, Louisiana Estuaries, 1968-1969
Report No. 8	Controlled Diversions in the Mississippi Delta System: An Approach to Environmental Management
Report No. 8-S	Hydrologic and Meterologic Data from Coastal Louisiana Evaluation of Data Gaps
Report No. 9	Deterioration and Restoration of Coastal Wetlands
Report No. 10	Selected Environmental Parameters, Coastal Louisiana, 1945-1946, 1959-1965
Report No. 11	Statistical Model for Salinity Distributions, Southeastern Louisiana Estuaries
Report No. 12	Wave Energy Studies along the Louisiana Coast
Report No. 13	Development of the Atchafalaya Delta, Louisiana
Report No. 14	Canals, Dredging, and Land Reclamation in the Louisiana Coastal Zone
Report No. 15	Measurement of Louisiana Coastal Shoreline
Report No. 16	Hydrologic Models for the Barataria - Terrebonne Area, South Central Louisiana
Report No. 17	The Shell Dredging Industry; Its Impact on Louisiana
Report No. 18-1	Multi-Use Management Plan for South Central Louisiana
Report No. 18-2	Environmental Atlas

A.2.8. The report, "Mouth of the Mississippi River, Louisiana," published as House Document No. 215, 76th Congress, recommended the combination of the existing deep-draft projects on the river under a

Breton Sound Estuary," in January 1981. The main objective of the management plan is to improve the environment of the estuary by reducing saltwater intrusion, enlarging nursery and harvesting areas, and retarding the rate of land loss. The plan states that these goals can be achieved by managing the salinity gradient. Extending the gradient seaward will largely eliminate the problem of saltwater intrusion and will maximize production of vegetation and commercial and sport organisms. Increased production of vegetation will retard land loss by directly contributing to land building and by reducing the rate of erosion. A steeper salinity gradient will maintain desirable ecological conditions within the marsh area. The report recommended that a diversion structure be located in the river levee near Caernarvon to discharge into Big Mar (river mile 81.5).

A.2.7. The Center for Wetland Resources, Louisiana State University, was retained under contract by the USACE to perform a number of basic studies of the hydrologic and geologic characteristics of coastal Louisiana. The studies examined and identified trends resulting from natural processes and the works of man in the coastal area, identified significant environmental parameters, determined freshwater requirements to implement changes for fish and wildlife enhancement, and developed management and structural approaches to solving problems in the estuarine environment. The findings and recommendations are contained in a series of 18 reports. The last report was published in late 1973. The 18 reports are listed below:

Report No. 1	Geologic and Geomorphic Aspects of Deltaic Processes, Mississippi Delta System
Report No. 2	Salinity Regimes in Louisiana Estuaries
Report No. 3	Water Balance in Louisiana Estuaries
Report No. 4	Summary of Salinity Statistics, Coastal Louisiana Stations, 1946-1968

Louisiana Legislature Act 561 of 1978, summarizes the existing information on marsh loss, saltwater encroachment, and barrier island deterioration, identifies possible freshwater and sediment diversion sites, establishes a study cost and time frame for completing a freshwater diversion plan for the state, and describes mechanisms for implementing the plan. The plan includes the four freshwater diversion sites in the Mississippi Delta Region project (see paragraph A.2.2) and several sites currently being investigated under the Louisiana Coastal Area study. In partial response to the POS, the Louisiana Department of Natural Resources published a draft report, "Recommendations for Freshwater Diversion to Louisiana Estuaries East of the Mississippi River" dated June 1982. The draft report recommended, among other things, the Caernarvon and Bonnet Carre' Spillway as sites for freshwater diversion. Subsequently, the Senate and House Committees on Natural Resources issued a "Report on Special Projects for Coastal Louisiana" in October 1981. The report identifies and discusses the particular problems of land loss, coastal erosion, wetlands deterioration, and saltwater intrusion as well as the potential solutions readily available to fight the processes adversely affecting coastal Louisiana. Specific projects are suggested in the discussion of solutions. The committees directed the administrator of the Coastal Management Section, Department of Natural Resources, to make recommendations to them on projects to control coastal erosion and wetland loss. The administrator of the Department of Natural Resources recommended a series of pilot projects for beach erosion and marsh building, and specified, as a part of the recommended plan, that the Caernarvon freshwater diversion project be given top priority. Because the Caernarvon site was included in the USACE authorized Mississippi Delta Region project, the Governor of Louisiana provided a letter of intent to the USACE on 26 January 1982 for the Caernarvon structure.

A.2.6. The Plaquemines Parish Commission Council, Plaquemines Parish Mosquito Control District, issued a report, "The Management Plan for the

essential inputs for the fish and wildlife study resulted in the following products: a vegetative type map depicting conditions in the coastal marshes during August 1968, collection and analysis of soil and vegetative types, a game inventory to determine habitat preference of important commercial and sport wildlife species, analyses of resources and resource development needs in connection with estuarine ecology to establish the relationship between commercial fish production and environmental charactertistics of the estuarine ecosystem, and the sport fishing, hunting, and wildlife-oriented recreational demand and activity in coastal Louisiana.

A.2.4. The New Orleans-Baton Rouge Metropolitan Area (NOBRMA) Louisiana Water Resources study was authorized by a resolution of the Committee on Public Works of the United States House of Representatives, adopted 14 June 1972. In the NOBRMA study, conducted by the New Orleans District, reports for the Lake Pontchartrain and Vicinity, Amite River and Tributaries, Louisiana, and other pertinent reports were reviewed with a view to determining whether any modifications of the recommendations contained therein are advisable, with particular reference to providing a plan for development, utilization, and conservation of water and related land resources of the New Orleans-Baton Rouge metropolitan region with due consideration for the urban planning activities of the region. Water and related resource areas investigated included wastewater management and water quality, flood control, water supply, recreation, environmental enhancement, and navigation. An "Inventory of Basic Environmental Data" was completed in 1975. The overall study was completed in 1981. The NOBRMA study includes all the parishes in the freshwater diversion study area.

A.2.5. The Louisiana Department of Transportation and Development prepared a plan of study (POS) dated April 1980 to investigate diverting freshwater and sediment to improve the coastal marshes, estuaries, and barrier islands of Louisiana. The POS, which is in response to the

LAND USE

A.3.12. The study area encompasses approximately 2.3 million areas of which 1.0 million acres is open water and the remaining 1.3 million acres is land. The land area is dominated by forested wetlands and nonforested wetlands (881,000 acres). Urban areas account for approximately 105,000 acres. The remaining 410,000 acres of land is distributed between agriculture, forest, and barren land. The study area is characterized by low relief with elevations varying from a maximum of approximately 30 feet NGVD at the crest of the Mississippi River levee to at or below NGVD in the marsh areas. Large areas in and below New Orleans have been leveed and require drainage by pumps. Deprived of replenishing sediment from the river, the drained soils are shrinking and subsiding. In some areas, elevations are as low as -10 feet. The most prominent topographic features in the area are the natural levees flanking the Mississippi River and its abandoned distributaries. These natural levees, several miles in width, form ridges that stand significantly above the surrounding swamps and marshes. Drainage in the area is away from the river and its elevated natural levees into adjoining wetlands. The wetlands make up the bulk of the land surface. They are broken and fragmented by numerous bayous, lagoons, canals, lakes, ponds, and smaller abandoned distributaries.

A.3.13. Lands adjacent to the Mississippi River are extensively developed for agricultural, industrial, urban, and suburban uses. Natural levee areas near the mouth of the river are largely undeveloped because they are too low and narrow to justify flood protection. Protected land along the river is used primarily for agriculture along with some suburban and industrial development. There is extensive urban, suburban, and industrial development in the vicinity of New Orleans and Baton Rouge. The lands between these metropolitan areas are developed primarily for agriculture along with some industrial and suburban development. The advantage the Mississippi River presents as a major

transportation corridor and continued and increasing restrictions on crops basic to the area have, however, accelerated a trend of decreasing agricultural activity and increasing industrialization.

A.3.14. Land being converted to industrial sites is, for the most part, located immediately adjacent to the river while recent residential development is mainly located near existing towns. Suburban or semirural development is also spreading along the river and is radiating out from larger population centers into the bordering wetlands. There still remains a considerable amount of agricultural land along the Mississippi River that has not been converted to other uses.

MINERAL RESOURCES AND PRODUCTION

A.3.15. Significant mineral deposits include crude petroleum, natural gas, natural gas liquids, sulfur, and salt. The total 1975 value of mineral production in the study area was $3,162,025,000, which is 37 percent of the value of the state's mineral production of $8,513,275,000. The value of mineral production in 1975 by parish is shown in table A-3-3. In 1975, some 20 percent of the nation's total petroleum production originated in coastal areas of Louisiana. Over 50 percent of Louisiana's petroleum production was produced in Barataria and Breton Sound Basins. Natural gas supplies also abound in the study area. Approximately 35 percent of the nation's total natural gas supplies flowed from wells in coastal Louisiana. The production was fairly evenly distributed along the coastline.

A.3.16. The majority of the sulfur produced in the state originates in the study area. Production in 1975 totaled about 90,000 long tons valued at $4.3 million. This constituted approximately three percent of the total production for the United States.

TABLE A-3-3

1975 VALUE OF MINERAL PRODUCTION IN THE STUDY AREA

Parish	Value (Thousands of Dollars)	Mineral Produced In Order of Value
Ascension	$ 82,116	Natural gas liquids, petroleum, salt, natural gas
Assumption	51,909	Natural gas, petroleum salt
Jefferson	547,223	Petroleum, natural gas, sulfur,natural gas liquids, salt
Lafourche	583,386	Petroleum, natural gas, sulfur, natural gas liquids
Orleans	38,333	Cement, stone, lime, natural gas, petroleum
Plaquemines	1,697,159	Petroleum, natural gas, sulfur, natural gas liquids, salt
St. Charles	127,781	Petroleum, natural gas liquids
St. James	24,418	Petroleum, natural gas, natural gas liquids
St. John the Baptist	9,700*	Petroleum, natural gas
TOTAL	$3,162,025	
TOTAL FOR STATE	$8,513,275	

SOURCE: The Mineral Industry of Louisiana, Bureau of Mines Mineral Yearbook, US Department of the Interior, 1975.

*1974 Value. The 1975 value was withheld to avoid disclosing individual company confidential data.

A.3.17. All major salt domes in production in the state are located in central coastal Louisiana, which encompasses a portion of the study area. Nearly all of the 12 million short tons produced in 1975 came from these domes. The production was valued at $77.1 million, representing about 30 percent of the total U. S. production.

TRANSPORTATION

A.3.18. The area is served by an extensive transportation system. Deep draft navigational access is provided to the Ports of New Orleans and Baton Rouge and industries by the Mississippi River, Mississippi River-Gulf Outlet (MR-GO), and the IHNC. Shallow draft access is provided by numerous inland waterways including the GIWW and the Barataria Bay Waterway.

A.3.19. The Port of New Orleans is the world's largest grain port. It is the largest seaport in the U. S. and the second in the world in terms of dollar value and waterborne tonnage handled. More than 5,000 ships call at its docks each year. The port serves midcontinent-United States where about one-third of the nation's population resides. The port handled 70.2 million tons of foreign trade in 1979. Coastwise traffic was approximately 13.1 million tons and internal traffic about 84 million tons. At any given time, one of every four barges in the United States is in the New Orleans area. The Port of New Orleans comprises 295 piers, wharves, and docks. Twenty-five linear miles of facilities are located along both banks of the Mississippi River. Other facilities are located along IHNC, Michoud Canal, the MR-GO, the Harvey and Algiers Canals, Bayou Sauvage, and Bayou Barataria.

A.3.20. Other vital forms of transportation that serve the area include mainland railroads, Federal interstate and Federal and state highways, and a formidable network of oil and gas pipelines. The New Orleans area is served by eight trunk line railroads that connect the city with other

cities. Rail lines extend along the alluvial ridges as far south as the GIWW and along the Mississippi River to just below New Orleans.

A.3.21. Two major Federal interstate highways are located just north of coastal Louisiana: Interstate 10 running generally east-west, and Interstate 55, a north-south thoroughfare. Other significant Federal highways include U. S. Highway 90, the primary east-west artery in the coastal area, U. S. Highway 1 to the northeast, U. S Highway 51 to the north, and U. S. Highway 71 and U. S. Highway 165 to the north from the west. State and local roads make up the bulk of the land transportation network. With few exceptions, the state and local roads are paved.

A.3.22. The vast network of pipelines in the area has superseded barge transport as the primary carrier of petroleum products. In 1967, south Louisiana had more than 11,000 miles of natural gas pipelines and almost 3,000 miles of crude petroleum pipelines. Offshore, there were more than 2,000 miles of pipeline for transporting petroleum raw materials. The largest crude oil line in the United States extends from coastal Louisiana to the midwestern United States. The crude oil line, 40 inches in diameter, has a capacity of 1 million barrels per day.

LAND RESOURCES

GEOLOGY AND PHYSIOGRAPHY

A.3.23. The study area is in the Deltaic Plain, which is located in the central Gulf Coastal Plain physiographic province. The oldest deposits are of the Pleistocene Age. These deposits outcrop in the vicinity of Baton Rouge and dip beneath the surface in a southwesterly direction. At the end of the Pleistocene Age, sea level had been lowered 400-450 feet below its present level and the Mississippi River valley system had become deeply entrenched in the coastal plain sediments. Approximately 3,500 to 5,000 years ago, as sea level approached its present stand, the

entrenched valley was gradually filled with Holocene (recent) alluvial sediments that covered the exposed weathered and eroded surface of the Pleistocene Age. After the sea reached its present level, the Mississippi River migrated back and forth across the alluvial plain, building a series of delta complexes. The river continually shifted the center of deposition to areas with steeper gradient. The shifting displaced the gulf waters with deposts of fine-grained material eventually forming the existing deltaic plain.

A.3.24. The Deltaic Plain comprises four abandoned deltas and the active delta (plate A-2). The inactive deltas are, from oldest to youngest, the Maringouin Delta, the Teche Delta, the St. Bernard Delta, and the Lafourche Delta. The active delta is the Plaquemine Modern Delta. Each delta was initiated when the Mississippi River migrated into the area and deposited sediments. The Maringouin and Teche Deltas were formed when the Mississippi River occupied westerly courses. Later, the river diverted to the east to form the St. Bernard Delta, then migrated westward to form the Lafourche Delta, and finally migrated to its present course. In the early growth phase, deposition centered in the northern portion of the delta. As a delta lobe extended gulfward, the channel enlarged, bifurcated, and reunited, forming an intricate network of distributaries, channels, levees, and interdistributary areas. Later, some distributaries were favored while others were abandoned. In the last phase, deposition occurred primarily seaward of the distributary mouths in the vicinity of the barrier islands. After abandonment, the delta subsided. Subsidence allowed the gulf to advance over the delta to form lakes, bays, and sounds, and invade the interdistributary areas. During this time, the sediments at the distal end of the delta were reworked and redeposited as the barrier island chains. The Breton-Chandeleur Island chain is approximately 50 miles long and 1 mile wide and lies approximately 20 miles offshore. The Grand Isle-Grand Terre island chain is approximately 20 miles long and 1 mile wide. Inland, the most prominent features are the natural levees of the

abandoned Mississippi River distributaries and the marshes. The active or Plaquemine-Modern "birdfoot" delta was initiated about 1,000 years ago. During the past 450 years, the delta has prograded an additional 50 miles to form the present day delta. The major outlets or passes have prograded close to the edge of the continental shelf. Consequently, most of the sediment carried by the river is dispersed into deep water beyond the reach of littoral currents. Deprived of the Mississippi River sediment, the delta flanks are retreating, the bays between the passes are enlarging, and there is little accretion of new land. Elevations in the wetlands, which comprise most of the land area, range from slightly below to just above sea level. The lowest elevations occur within the New Orleans metropolitan area where the ground is commonly several feet below sea level. Higher elevations occur on the natural levees and on some relict beach/dune ridges inland from the coastline. The highest natural ground elevations, 7 feet, occur on the crests of the dunes of Grand Isle. Elevations on the crest of the artificial levees along the Mississippi River exceed 30 feet.

A.3.25. When considered through geologic time, the deltaic system is always in delicate balance. On one side, there is the input of discharge and sediment and on the other side, there are such factors as coastal erosion, saltwater intrusion, and subsidence that cause coastal deterioration. In modern years, it has been necessary to alter natural deltaic processes to prevent flooding and to improve navigation. As a result of such controls, virtually all overbank flooding has been prevented. Except for the Mississippi River birdfoot delta, practically all of the study area is suffering from land loss caused by erosion, subsidence, and saltwater intrusion.

A.3.26. Subsidence is caused by natural processes such as true or actual sea level rise, consolidation of sediments, basement sinking caused by sediment load or subcrustal flow, and tectonic activity. The marshes subside to depths that kill the marsh plants. The loss of

living marsh exposes the organic marsh sediment to easy erosion. Erosion of the sediment and accelerated compaction deepen the bays and channels. Greater volumes of saline water can then pass through and penetrate even deeper into the marshes. Gagliano et al. (1970), determined that areas of maximum land loss coincide with areas of maximum subsidence. A mean subsidence rate of 0.5 foot per century has been determined for coastal Louisiana.

SOILS

A.3.27 The Mississippi River channel is incised in recent and Pleistocene deposits. Generally, on the concave sides of the river bends, the banks are composed of more recent materials consisting of a topstratum of fine-grained soils overlying and, in some areas, contacting Pleistocene Age deposits laterally. Between Donaldsonville (river mile 178.0) and Kenner (river mile 125.0), Louisiana, this relatively fine-grained topstratum consists of natural levee, undifferentiated deltaic plain swamp, and marsh materials. Between Kenner and the gulf, the topstratum on the concave sides of the bends consists of natural levee, swamp, marsh, abandoned distributary, interdistributary, intradelta, prodelta, and nearshore gulf deposits. On the convex sides of the bends, the topstratum consists of accretionary and point bar deposits. The more recent topstratum deposits are underlain by Pleistocene Age materials throughout the area. A general physical description of the soils in the various geologic environments follows:

Natural Levee - Interfingering layers of fat and lean clays and layers of silt.

Pointbar - Silts, silty sands, and sands with layers of clay.

Accretionary - Alternating layers of clay, silt, silty sands, and sands.

Abandoned distributaries - Layers of fat and lean clays, silts, and silty sand wedges at juncture of present course.

Abandoned Course - Layers of fat and lean clays and silts in upper portions with sands in lower portion.

Backswamp - Homogeneous fat clays with wood, organic matter, and a few layers of silt.

Undifferentiated deltaic plain - Fat and lean clays with lenses and layers of silt.

Marsh - Organic clays, silts, and oozes with plant roots and particles (grasses and sedges).

Swamp - Organic clays and silts with decayed wood (trees and shrubs).

Interdistributary - Fat clays with thin lenses and layers of silt and a few thin layers of fine sand.

Intradelta - Interfingered layers of silt, silt sands, and sand with lenses and layers of fat clay (forms the sandy "barfinger" wedges at the mouth of the river).

Prodelta - Homogeneous fat clays of medium consistency.

Nearshore Gulf - Silty sands and sand with shells.

Estuarine - Silts, silty sands, and sandy (reworked) with shells.

Substratum - Massive sands grading to gravelly sands and gravel with depth.

Pleistocence - Stiff to very stiff oxidized clays with lenses and layers of silt, silty sands, and sand.

WATER RESOURCES

CLIMATE

A.3.28. The climate is warm and humid subtropical due to its latitude and proximity to the Gulf of Mexico. The area has mild winters, hot summers, heavy precipitation, and generally high humidity. Prevailing winds are southeasterly during the spring, southwesterly in the summer, and northeasterly in the fall and winter. In the coastal area, winds

have a strong impact on coastal water levels. Winds from a southerly direction may push water into the bays and lakes, frequently raising water levels in the upper part of the estuarine zone. On the other hand, winds from a northerly direction may depress water levels.

A.3.29. The general circulation of air over the area follows the sweep of the western extension of the Bermuda High during the spring and summer months. High pressure systems over the North American continent modify the patterns for the remaining months. These high pressure systems and their associated extratropical cyclones are responsible for the wide pressure ranges of winter. The Bermuda High has greater constancy than the continental high pressure systems and in late spring and summer maintains a rather steady flow of warm, moist air that, to a large degree, controls the climate over the area. Periods of good weather tend to be longer during late spring and summer than during late fall, winter, and early spring. The monthly mean pressures range from a maximum of 30.1 inches of mercury in December and January to a minimum of 29.97 in September.

A.3.30. Many polar air masses and associated frontal conditions penetrate to the Gulf of Mexico each winter. During the cooler season, some 15 to 20 of these systems bring strong northerly winds, cold temperatures, and adverse weather. These polar air masses ordinarily occur from November to March and last about a day and a half. Severe polar air masses usually occur from December to February and occasionally later, and may last for 3 to 4 days.

A.3.31. Hurricanes or tropical storms originating in the North Atlantic and Caribbean Sea occasionally come into the study area during the hurricane season, June through October. Winds and waves generated by these storms have caused substantial damage to the marshes and have contributed to erosion and land loss. The greatest hurricane ever recorded in North America, Hurricane Camille, entered the study area in August 1969. The hurricane had peak winds of 190 miles per hour.

A.3.32. Monthly mean relative humidities are high throughout the year with negligible seasonal variation because of the influence of the gulf waters. Maximum values of the monthly means occur during spring, the time of greatest consistency of southeasterly winds. Minimum humidities occur during the fall.

HYDROLOGY

A.3.33. There are three hydrologic basins in the area: the lower Mississippi River Basin, the Breton Sound Basin, and the Barataria Basin. The Mississippi River water originates almost entirely from outside the study area. The levee system along the river serves as a funnel passing the runoff from about one-third of the United States through the study area to the Gulf of Mexico. Discharges at Baton Rouge range from 1,500,000 cubic feet per second (cfs) once every 16 years on the average to a low of 75,000 cfs, recorded once during the period of record. The IHNC and the upper reaches of the MR-GO contributes about 10 percent of the tidal flows into Lake Pontchartrain.

A.3.34. The Breton Sound Basin is bounded on the west and south by the Mississippi River and on the north by the Bayou Terre aux Boeufs alluvial ridge and the MR-GO dredged material disposal area. Rainfall and urban stormwater runoff is the primary source of freshwater in the basin. Freshwater in the lower portion of the basin is provided by several diversion structures built by the State of Louisiana and through breaks in the lower Mississippi River levee. Drainage is provided by natural and manmade canals that flow away from the Mississippi River and ultimately discharge into Breton Sound and the Gulf of Mexico. Pumps are used to evacuate rainfall runoff from leveed urban areas located along the Mississippi River. The basin is mostly wetlands with numerous bays, lakes, and estuaries and marshes. The major waterways include Caernarvon Canal, Bayou Terre aux Boeufs, and River aux Chene. The major inland water bodies are Big Mar, Lake Lery, and Grand Lake. The

shoreline is deeply indented by numerous bays including Black, American, California, Quarantine, and Grand Bays.

A.3.35. Barataria Basin is well-defined and comprises the area between the Mississippi River and Bayou Lafourche. Freshwater input to the basin is primarily from rainfall and urban storm water runoff, municipal discharges, and flow from the Mississippi River through the Harvey and Algiers locks. Drainage in the basin tends to flow away from the natural levee of the Mississippi River bordering on the east and the Lafourche Alluvial Ridge bordering on the west. Surface waters are collected in natural streams and manmade canals. The major waterways are Grand Bayou Boeuf, Bayous Des Allemands, Segnette, des Familles, Barataria, Dupont, Rigolette, and Perot, and GIWW. Flows move from the upper part of the basin to Barataria Bay and from there to the Gulf of Mexico through a series of interconnected bayous and lakes. Major water bodies are Lac Des Allemands, Lakes Cataouatche and Salvador, Little Lake, and Barataria and Caminada Bays.

A.3.36. Currents and circulation patterns are influenced by water movements in the Gulf of Mexico. The nearshore patterns are induced by currents flowing northeast from the Yucatan Channel toward the Mississippi River delta. At the delta, the current divides into eastern and western components. The eastern current flows north and east of the Breton and Chandeleur Islands, and the western current follows the coastline. The currents are modified, however, by wind, bottom topography, and Mississippi River discharges.

A.3.37. The littoral drift east of the Mississippi River is generally to the north and east into Breton and Chandeleur Sounds, while the littoral currents south of the delta generally move westward. The only exception is an area near South Pass that is mixed due to the intersection of oceanic waters with river waters. West of the delta, the littoral drift is northwest and north to the Bayou Lafourche area.

In the offshore area south of Bayou Lafourche, the littoral drift divides. One component continues westward. The other current flows northeasterly across the area of the gulf south of the Barataria Bay. The result of these combined currents is a clockwise current flow in the area of the gulf west of the delta and south of Barataria Bay.

A.3.38. Within the estuaries, the water circulation pattern depends on the hydraulic gradients produced by tidal action at the mouth of the estuaries, the freshwater inflows from upstream drainage areas, and the wind.

A.3.39. Current velocities average between 0.4 and 0.6 knots in the offshore area. Littoral current velocities increase slightly, averaging between 0.7 and 1.0 knots. The velocity changes with the season. The flow is generally faster in the spring and summer than in the autumn and winter. Current velocities in major waterways normally vary from 0.1 to 2.5 knots, but are greater during high water discharge.

A.3.40. The mean tide elevation on the coast of Grand Isle in the study area is about 0.848 NGVD. The daily astronomical tide ranges vary from neaps of about 0.2 feet to springs of 2.2 feet. The area generally has diurnal tides, that is, one high tide and one low tide in a day. Influence from tides is felt as far inland as Lac Des Allemands in the Barataria Basin and Lake Lery in the Breton Sound Basin.

A.3.41. In addition to affecting the circulation patterns of the estuaries, the wind frequently modifies the range and height of the tides. Strong southerly winds frequently raise water levels in the estuaries about 1 or 2 feet above normal. Conversely, strong northerly winds push water out of the marsh, depressing water levels 1 or 2 feet below normal.

WATER QUALITY

A.3.42. Several standards applicable to all waters in the state and numerical standards applicable to specific major water bodies, their tributaries, and distributaries have been published by the Louisiana Department of Natural Resources - Water Pollution Control Division (LDNR-WRCD). The numerical standards apply to the pH range, temperature, bacterial density, and dissolved oxygen (DO) concentration in waters in the state. Standards also address ambient concentrations of chlorides, sulfates, and total dissolved solids (TDS) in nontidal waters. The numerical standards are intended to protect and enhance the inorganic and sanitary quality of state waters for currently designated and potential future uses.

A.3.43. The reach of the Mississippi River within the study area includes portions of state stream segments 0701 and 0705 and has been designated as a Class B water body by the LDNR-WPCD. Class B waters are considered suitable for any use or activity where human ingestion of the untreated water is not probable. Such uses or activities may include secondary contact recreation, propagation of fish and wildlife, and domestic raw water supply. Both stream segments 0701 and 0705 are classified as "water quality limited" due, primarily, to consistently high total and fecal coliform bacteria densities, and recurrent taste and odor problems associated with phenolic compounds. Within the river reach mile 155 to mile 75 AHP, contraventions of the state DO standard of 5.0 mg/l were noted for only 46 of the 2,340 observations during the period 1958 through 1980. Contraventions of the chloride, sulfate, TDS, pH, and temperature standards have been similarly infrequent.

A.3.44. There are no numerical state standards for ambient nitrogen and phosphorus concentrations. However, two forms of these macronutrients are of particular significance in the quality characterization of a water body: un-ionized ammonia because of its toxicity to aquatic life,

study area and sometimes function as vectors, transmitting disease organisms to other animals and humans. Mosquitoes are the most notable vectors, although other insects including flies and midges sometimes transmit disease organisms. Hydraulic dredging can potentially increase the breeding habitat for *Aedes sollicitans* (salt marsh mosquito), which breeds in temporary water areas, and *Culex salinarius*, which requires permanent water bodies for breeding. Although many species of mosquitoes are in the area, *A. sollicitans* and *C. salinarius* are probably the most abundant and represent the greatest vector potential. *A. sollicitans* is a known vector for eastern equine encephalitis, western equine encephalitis, California encephalitis, and Venezuelan equine encephalitis. The various strains of viral encephalitis are periodically found in native wildlife populations that serve as reservoirs for vival inoculum.

A.3.76. Endangered species known to occur or suspected to occur in the study area include the Eskimo curlew, Arctic peregrine falcon, bald eagle, brown pelican, Bachman's warbler, Eastern cougar, West Indian manatee, blue whale, humpback whale, sperm whale, sei whale, leatherback sea turtle, hawksbill sea turtle, and Kemp's ridley sea turtle. Threatened species in the area include the loggerhead and green sea turtles. The range of 54 species of birds listed in the 1981 "Blue List" published by the National Audubon Society includes the study area. The "Blue List" cites bird species that are showing indications of noncyclical population decline or range contraction, either locally or throughout their range.

A.3.77. Fisheries. Fresh-to-saline water bodies interspersed throughout the area include ponds, lakes, bayous, streams, canals, bays, sounds, tidal passes, and navigation channels. This diversity of aquatic habitat types supports a wide range of finfish and shellfish resources important from a commercial, recreational, and ecological standpoint.

A.3.72. A wide variety of nongame birds are found in the area including seabirds, shorebirds, wading birds, songbirds, and raptors. A total of 43 sea and wading bird nesting colonies exist within the area. Wading birds are present in the forested wetlands and marshes and include such species as the Louisiana heron, great blue heron, black-crowned night heron, yellow-crowned night heron, green heron, cattle egret, reddish egret, great egret, snowy egret, white ibis, and white-faced ibis. Shorebirds common to the area include the black-necked stilt, semi-palmated plover, black-bellied plover, wimbrel, killdeer, willet, greater and lesser yellowlegs, and numerous sandpipers. Seabirds include the brown pelican, white pelican, herring gull, ring-billed gull, laughing gull, Forster's tern, royal tern, Caspian tern, gull-billed tern, and black skimmer.

A.3.73. Common raptors include the marsh hawk, red-shouldered hawk, red-tailed hawk, barred owl, and American kestrel. Other nongame birds inhabiting the area are the Carolina wren, robin, cardinal, long-billed marsh wren, white-eyed vireo, boat-tailed grackle, eastern kingbird, red-winged blackbird, and belted kingfisher.

A.3.74. Numerous species of reptiles and amphibians are found in the study area. The American alligator, common snapping turtle, alligator snapping turtle, diamondback terrapin, smooth and spiny softshell turtles, red-eared turtle, stinkpot, green anole, broad-headed skink, diamondback water snake, banded water snake, Gulf salt marsh snake, and western cottonmouth are representative reptiles. Amphibians in the area include the bullfrog, pig frog, bronze frog, leopard frog, lesser siren, gulf coast toad, green and squirrel treefrogs, cricket frog, and several species of salamanders.

A.3.75. A wide variety of terrestrial invertebrates can be found in the area including arthropods, snails, annelids, nematodes, and proto-zoans. Insects are the most important terrestrial invertebrates in the

TABLE A-3-4

FUR CATCH AND VALUE

	Marsh Type		
Species	Fresh/Intermediate	Brackish	Saline
Muskrat			
Average catch/acre a/	0.0880 b/	0.0844	0.0169 c/
Value/pelt d/	$5.70	$ 5.70	$5.70
Value/acre	$0.5015	$ 0.4811	$0.0963
Nutria			
Average catch/acre	0.3988 b/	0.0864	insignificant
Value/pelt	$7.76	$ 7.76	-
Value/acre	$3.0940	$ 0.6703	insignificant
Mink			
Average catch/acre	0.0015 b/	0.0011	insignificant
Value/pelt	$14.36	$14.36	-
Value/acre	$ 0.0215	$ 0.0158	insignificant
Otter			
Average catch/acre	0.0005 b/	0.0002	insignificant
Value/pelt	$46.80	$46.80	-
Value/acre	$ 0.0234	$ 0.0094	insignificant
Raccoon			
Average catch/acre	0.0093 e/	0.0078 f/	insignificant
Value/pelt	$12.03	$12.03	-
Value/acre	$ 0.1119	$ 0.0938	insignificant
TOTAL			
Average catch/acre	0.4979	0.1799	0.0169
Gross value/acre	$3.75	$ 1.27	$0.0963
Net value/acre	$2.82	$ 0.96	$0.07

a/ Average catch per acre, unless otherwise noted, from Palmisano (1973).

b/ Represents mean of fresh and intermediate marsh average harvest/acre.

c/ Calculated as 25 percent of brackish marsh average harvest/acre.

d/ Based on a 1976-81 running average of prices received by the trapper, expressed in 1983 dollars using the CPI Index for Hides, Skins, Leather, and Related Products.

e/ Represents one half of the combined maximum production for fresh and intermediate marsh types.

f/ Represents one-half the maximum value.

g/ Cost of harvest is 25% of gross returns.

marshes. Squirrels are found in the wooded habitats and the Eastern cottontail is primarily found in close association with agricultural lands, fence rows, and the ecotone region along forest edges.

A.3.69. The primary commercially important furbearers are nutria, muskrat, raccoon, mink, and otter. The per-acre harvest and value of these species in the various marsh types in coastal Louisiana are presented in table A-3-4. Both fresh/intermediate and brackish marshes are important for the production of muskrat while fresh/intermediate marshes are the most productive for nutria. Other species of mammals harvested for furs to a lesser degree include opossum, bobcat, beaver, and red and gray foxes.

A.3.70. A variety of nongame mammals occur in the area including the white-footed mouse, short-tailed shrew, eastern wood rat, and nine-banded armadillo. The only common marine mammal found in the area is the bottle-nosed dolphin, which inhabits the bays, sounds, and tidal passes.

A.3.71. A great diversity of avian fauna is in the area and valued by both birdwatchers and sportsmen. A variety of migratory waterfowl overwinter in the coastal marshes. Included are mallards, green and blue-winged teal, pintails, wigeons, shovelers, gadwalls, ring-necked ducks, redheads, canvasbacks, lesser and greater scaup, mergansers, ruddy ducks, buffleheads, common goldeneyes, and a few black ducks. Wood ducks nest in the wooded swamps and seasonally flooded bottomland hardwoods, and wood duck migrants winter in the area. Mottled ducks are a resident species and nest in the fresh to brackish marshes. The only geese that winter in significant numbers are lesser snow geese. Other game birds include coots, rails, gallinules, snipe, woodcock, and mourning doves.

herbaceous vegetation includes duckweeds, alligatorweed, water hyacinth, swamp lily, and lizard's tail. Other herbaceous plants of these swamps are spiderlily, sedges, smartweed, cattail, water hyssop, and water paspalum. Aquatics that can be found in standing water include frogbit, water hyacinth, duckweed, watermeal, and great duckweed. Wooded swamps are productive fish and wildlife habitats and serve an important hydrologic function by storing and regulating the flow of fresh water to marshes and estuaries seaward. A total of 170,780 acres of wooded swamp occurs in the study area, 169,774 acres in the Barataria Basin, and 2,006 acres in the Breton Sound Basin. Wooded swamps have experienced severe losses in the Breton Sound Basin because of saltwater intrusion.

A.3.66. Agricultural Lands. Sugarcane is the dominant crop in the study area. Other crops include soybeans, cotton, corn, citrus fruits, and a variety of truck crops. Pastureland and rangeland also occur in the area. Approximately 100,000 acres of cropland and 77,000 acres of pastureland and rangeland were in the study area in 1978.

ZOOLOGICAL

A.3.67. Wildlife. The diversity and areal extent of productive habitat types in the study area support a wide variety of wildlife including game species, commercially important furbearers and alligators, endangered species, and numerous nongame species that are important from an ecological standpoint.

A.3.68. A variety of small game mammals are in the study area and hunted by sportsmen. The only big game animal is the white tailed deer that primarily inhabits the bottomland hardwoods and wooded swamps but is also found in the fresh marshes in the vicinity of higher ground. The primary small game animals are the swamp rabbit, Eastern cottontail, gray and fox squirrels, and raccoon. The swamp rabbit and raccoon inhabit the bottomland hardwoods, wooded swamps, and fresh to brackish

Basin. Saline marshes occur along the shorelines of the Gulf of Mexico, large bays, and leeward of barrier islands. Saline marsh has a mean salinity of 18.0 ppt. Vegetation typical of this marsh type includes oystergrass, glasswort, black rush, saltwort, black mangrove, and salt grass. The total saline marsh acreage is 204,255 acres, 157,489 acres in the Barataria Basin and 46,766 acres in the Breton Sound Basin. Both brackish and saline marshes provide spawning and nursery areas for many estuarine-dependent species including shrimp, oysters, crabs, and finfishes.

A.3.64. Bottomland Hardwood Forest. This forest type is also referred to as natural levee forest and occurs in the area along the Mississippi River and its abandoned distributary ridges. Seasonal flooding occurs over portions of the forests. Common trees in the wetlands include water oak, Nuttal oak, green ash, Drummond red maple, mayhaw, green hawthorn, water locust, and some baldcypress. Species found on higher ground include live oak, hackberry, American elm, sweetgum, dedicuous holly, and honey locust. Shrubs and vines found in association with bottomland hardwoods include palmetto, elderberry, waxmyrtle, eastern baccharis, rattan vine, ladies eardrops, greenbriar, trumpet creeper, cross vine, poison ivy, Virginia creeper, peppervine, marsh elder, rattlebox, and various sedges and grasses. Bottomland hardwoods are valuable for wildlife production and are becoming increasingly scarce in the area. A total of 52,949 acres of this habitat type occurs in the study area, 43,470 acres in the Barataria Basin and 9,479 acres in the Breton Sound Basin.

A.3.65. Wooded Swamp. This habitat type consists of semipermanently flooded, forested wetlands and is generally found inland from the fresh marshes. Dominant species include baldcypress, tupelogum, Drummand red maple, and buttonbush. Other species include pumpkin ash, Carolina ash, blackgum, black willow, water elm, and a variety of shrubs such as Virginia willow, palmetto, pepperbush, wax myrtle, and titi. Dominant

swamps and, as the distance from the river increases, to plants associated with fresh, intermediate, brackish, and saline marshes. All common names of plants mentioned in this appendix follow Montz (1975a, 1975b) and are listed in Section 1 of Appendix D, Natural Resources. All estimates of habitat acreage given in this section are based on 1978 conditions.

A.3.62. <u>Marshes</u>. The marshes in the study area are classified as fresh, intermediate, brackish, and saline. The general distribution of these marsh types is shown on plate A-6. Fresh marsh has a mean salinity of 1.0 parts per thousand (ppt) and is generally located between wooded swamps and intermediate marshes. Vegetation typical of fresh marsh habitats includes maidencane, pennywort, water hyacinth, pickerelweed, alligatorweed and bulltongue. Intermediate marshes are located between the fresh and brackish marshes and have a mean salinity of 3.3 ppt. Intermediate marsh is characterized by a diverse plant community composed of wiregrass, deerpea, roseau, bulltongue, wild millet, walter's millet, smartweed, bullwhip, and sawgrass. Fresh and intermediate marshes are highly productive habitats for wildlife, including furbearers, waterfowl, and alligators, and serve as spawning and nursery areas for various fish and shellfish species. For the purposes of this study, fresh and intermediate marshes were combined and referred to as fresh/intermediate marsh due to their nearly identical habitat values. A total of 210,242 acres of fresh/intermediate marsh occurs in the study area, 196,647 acres in the Barataria Basin and 13,595 acres in the Breton Sound Basin.

A.3.63. Brackish marsh occurs in the study area at moderate salinities between the intermediate and saline marsh zone and has a mean salinity of 8.1 ppt. Typical vegetation includes wiregrass, saltgrass, dwarf spikerush, three-cornered grass, leafy threesquare, and widgeon grass. A total of 242,918 acres of brackish marsh occurs in the area, 111,661 acres in the Barataria Basin and 131,257 acres in the Breton Sound

flooding of the river has exerted considerable control over salinities in estuarine bays and lakes. The river frequently inundated virtually all of the alluvial valley and deltaic plain for prolonged periods of time. However, since levees have been constructed along almost the entire lower reach of the Mississippi River, the water is directly discharged into the Gulf of Mexico. As a result, local runoff is the primary source of freshwater available for controlling salinities in the estuaries. In addition, curtailing Mississippi River flow to the marshes has deprived the area of sediment. These sediments have expanded the coastal area in the past. The forces of erosion and subsidence outweigh the forces of sediment deposition and have led indirectly to further saltwater intrusion.

A.3.60. In the Barataria and Breton Sound basins approximately 71.2 square miles and 12.9 square miles, respectively, of canals and channels were dredged from 1940-1970. The tidal shoreline increased by 1,557 miles and 561 miles, respectively, through 1970. The canals and channels in the marshes have provided avenues for seawater to invade the upper estuaries and marshes. They have also shortened the time that surface runoff requires to travel from the upper basin to the gulf, thereby reducing the detention time of the water in the swamps and marshes. Another significant consequence of the canals is the translation of the greater gulf tidal range into the marsh. During high tides, more saline water inundates the marsh and during low tides, larger areas of the marsh are more effectively drained.

BIOLOGICAL RESOURCES

BOTANICAL

A.3.61. Plant life in the study area is extremely diverse. Plant types range from bottomland hardwood forest and agricultural crops along the natural levees of the Mississippi and its abandoned courses to wooded

A.3.56. Salinity. The area has experienced a long-term rise in salinity levels. The rise can be observed through the changes in vegetation types. The saline marsh along the coast has expanded inland at the expense of the fresh and brackish marshes. Due to the paucity of long-term salinity data in this area, it is difficult to define the actual increases in salinity. The difficulty comes from the fact that most of the salinity stations are located in navigation channels with confined flows. Data from these stations may not be representative of salinities in the shallow, open water bodies and marshes. Seasonal salinity fluctuations occur depending on local rainfall, Mississippi River discharge, winds and tides.

A.3.57. Some subtle changes in salinity patterns have been observed. At the Lafitte station (table C-1-16, Appendix C, Engineering Investigations,) salinities for all months in the period 1964 through 1979 increased when compared to the 1956 through 1961 period. The greatest increases are noted in the spring, summer, and fall months. Three other salinity stations, Offshore Platform, St. Mary's Point, and Grand Terre slip exhibit progressively later annual salinity highs in October November, and December, respectively (see tables C-1-13, C-1-14, and C-1-15, Appendix C). This data may be a cumulative result and may reflect the general subsidence of the area and rising sea level that permits saline gulf waters to move northward and encroach into the estuaries.

A.3.58. A definitive conclusion that salinities have increased in the study area can be made by looking at the changes in vegetation in the marshes. A detailed discussion of these changes can be found in the Problems, Needs, and Opportunities section.

A.3.59. The most dominant factor in the trend toward increased salinity levels in the marshes has been the extensive flood control program in the lower reaches of the Mississippi River. Historically, overbank

A.3.53. Summary data and histograms of pesticide and PCB detection frequencies in the Barataria Basin and Breton Sound estuary are presented in plates H-35 through H-40, Appendix H. The organochlorine compounds have been detected in less than 7 percent of the samples collected. The organophosphorus insecticides have detection frequencies of 30 to 64 percent and the phenoxy herbicides have detection frequencies of about 7 to 66 percent. In general, the higher frequencies of detection occur in the Barataria Basin north of the GIWW.

A.3.54. Trace Metals and Metalloids. The trace metals copper, zinc, and iron have been detected in the Mississippi River near New Orleans at concentrations of 1.1, 2.2, and 15.1 mg/L, respectively. Such high concentrations are rare; however, considering the enormous dilution capacity of the river, trace metals concentrations at these levels are cause for concern. Such high concentrations indicate the impact of industrial and urban stormwater discharges to the river. Data shown in table H-7-2, Appendix H, indicate that the trace metals cadmium and copper consistently exceed the EPA freshwater aquatic life criteria. These data indicate further recurrent exceedances of the EPA criteria for mercury, zinc, and lead.

A.3.55. As in the Mississippi River, copper concentrations in the Barataria Basin and Breton Sound estuary frequently exceed the EPA aquatic life criteria (fresh and saltwater criteria). Other metals that frequently exceed the EPA criteria include cadmium, lead, and mercury in the Barataria upland area, and mercury and zinc in coastal Barataria and in the Breton Sound estuary. Criteria exceedance frequencies are indicated in table H-7-4, Appendix H. Table H-7-5, Appendix H, presents data for concentrations of selected trace metals detected in oyster meat collected in the study area. These data highlight the ability of oysters to extract and bioconcentrate available trace metals from the water column, which is a characteristic of other estuarine organisms.

Breton Sound area, both the observed median fecal coliform density, 17 colonies/100 mL, and the 90th percentile density, 125 colonies/100 mL, are above the corresponding standard values. The data distribution indicates that the probability of a sample density exceeding the 43 colonies/100 mL value is about 33 percent.

A.3.51. Agricultural and Industrial Chemicals. Table H-6-1, Appendix H, lists the frequency of detection and percentage of observations exceeding the EPA aquatic life criteria for several pesticides in the Mississippi River. The most frequently detected of the phenoxy herbicides, organochlorine, and organophosphorus insecticides are 2, 4-D, dieldrin, and diazinon, respectively. Plates H-30 through H-32, Appendix H, present data regarding the frequency distributions of sample collection and criteria exceedance for the persistent organochlorine insecticides DDT, dieldrin, and endrin. These data, though not exhaustive, indicate decreasing trends in criteria exceedances for the insecticides. Residue concentrations of several pesticides detected in fish tissue from samples collected at various locations in the Mississippi River are shown in table H-6-2, Appendix H. The concentrations of pesticides shown are, in some cases, several orders of magnitude greater in the tissue samples than the maximum relative concentrations detected in the surface water. However, one of the five samples taken indicated a pesticide concentration above the corresponding Food and Drug Administration (FDA) action level. This sample had a chlordane residue concentration that exceeded the FDA action level of 300 parts per billion.

A.3.52. Because of the intense industrialization along the banks of the Mississippi River between Baton Rouge and New Orleans, a large variety of manmade organic compounds are discharged in this waterway. Table H-6-4, Appendix H, is a partial listing of organic compounds detected in a sample of raw river water collected at New Orleans on 9 April 1981.

These data are not directly comparable to the state bacterial standards; however, they do provide clues to the river's sanitary quality. The logarithmic mean (the value equalled or exceeded 50 percent of the time) of the observed fecal coliform density, 460 colonies/100 mL, is well below the value of 1,000/100 mL of the secondary contact recreation standard. However, the fecal coliform density equalled or exceeded 10 percent of the time, 3,000/100 mL, is well above the 2,000/100 mL value of the standard. The data distribution indicates that the probability of a sample exceeding the 2,000 colonies/100 mL value is about 18 percent. These data suggest that the secondary contact recreation standard is most probably violated with some regularity in the river.

A.3.50. The sanitary quality of the water of Barataria Basin and the Breton Sound estuary, characterized by the observed total and fecal coliform bacteria densities, is indicated by the data in table H-5-3, Appendix H. The logarithmic mean fecal coliform density in the Barataria Basin north of the GIWW is 64 colonies/100 mL and the 90th percentile value is about 600 colonies/100 mL. The corresponding values of the applicable primary contact recreation standard are 200/100 mL and 400/100 mL. The data distribution indicates that the probability of a sample density exceeding the 400 colonies/100 mL value is about 15 percent. Intermittent violations of the primary contact recreation standard are likely to occur in these waters. The state's shellfish propagation standard is applicable to the coastal waters in the Barataria Basin south of the GIWW and the Breton Sound estuary. The data distributions for these areas indicate probable frequent violations of the shellfish propagation standard. The median fecal coliform density of coastal Barataria Basin (8 colonies/100 mL) is less than the corresponding value of the shellfish standard (14 colonies/100 mL) and the 90th percentile density (125 colonies/100 mL) is well above the 90th percentile value of the standard (43 colonies/100 mL). The data distribution indicates that the probability of a sample density exceeding the 43 colonies/100 mL value is about 20 percent. In the

headwaters, water quality is generally poor. From 1958 through 1980, DO concentrations in three headwater streams, Bayous Grand, Chevreuil, and L'Onion, averaged only 2.6 mg/l with 90 percent of the 487 DO observations below the state standard of 5.0 mg/l. Contraventions of the state standard for chlorides were noted for 11 percent of the samples collected in these streams. Data from sampling stations in Bayous Des Allemands and Segnette and Lake Salvador are indicative of the surface water quality in the central portion of the basin north of the GIWW. From 1962 through 1980, DO in these surface waters averaged about 6.0 mg/l with about 34 percent of the DO observations below the state standard. A significant number of contraventions of the state standards for chloride and TDS concentrations (59 percent and 65 percent of the data records, respectively) were also noted in these waters. Nutrient data indicate inordinately high total ammonia and total phosphorus concentrations in streams draining the industrialized ridges in the nothern basin. Several studies of the basin's productivity have characterized the shallow lakes of the northern portion of the basin as hypereutrophic with frequent outbreaks of algal blooms and occasional fish kills.

A.3.47. In terms of contraventions of the state standards for DO, temperature, and pH, the quality of the coastal waters of the Barataria Basin south of the GIWW may be considered significantly better than the northern areas. Contraventions of the state standards for these parameters have occurred, but infrequently.

A.3.48. The coastal waters of the Breton Sound estuary are generally of good quality as indicated by the rare contraventions of the DO, pH, and temperature standards.

A.3.49. Bacteriological Quality. The sanitary quality of the Mississippi River, characterized by observed indicator organism densities, is presented in table H-5-1, Appendix H, Water Quality.

and phosphate because of its role in the accelerated aging and enrichment of lakes and estuaries. The U. S. Environmental Protection Agency (EPA) recommends in its Quality Criteria for Water that un-ionized ammonia concentrations not exceed 20 ug/l for the protection of freshwater aquatic life. To prevent the development of nuisance biological growth and control accelerated or cultural eutrophication, the EPA also recommends that total phosphate as phosphorus not exceed 50 ug/l in any stream at the point where it enters any lake or reservoir. The EPA criteria recommend further that total phosphorus not exceed 100 ug/l in streams not discharging directly to lakes or impoundments. Unionized ammonia concentrations computed from total ammonia, temperature, and pH data for the Mississippi River at New Orleans exceeded the EPA criterion in 80 of 337 samples (24 percent). Ninety-two percent (199 of 216) of the phosphate observations from samples collected in the river between miles 155 and 75 exceeded the 50 ug/l criterion and 94 percent (568 of 605) of the total phosphorus observations exceeded the 100 ug/l criterion. Although phosphorus concentrations in the river consistently exceed EPA recommendations, phosphorus is not a problem because the river's swift currents and the absence of quiet zones with poor circulation retard outbreaks of algal blooms.

A.3.45. The Barataria Basin is characterized by freshwaters in the upland basin adjacent to the Mississippi River grading to brackish and saltwaters in the lower basin south of the GIWW. Most of the major water bodies within the basin, with the exception of Lakes Salvador, Cataouatche, and Little Lake, have been designated as Class A waters by the LDNR-WPCD. Designated uses include primary contact recreation, secondary contact recreation, and propagation of fish and wildlife. Bayou Rigolets, Little Lake, and portions of the Barataria Bay Waterway have been designated as suitable for the production of shellfish.

A.3.46. Water quality within the basin improves dramatically away from the Mississippi River and Bayou Lafourche ridges. In the basin

A.3.78. The fishery resources include freshwater species that use primarily the fresh and intermediate areas, and marine species that use primarily the brackish and saline areas. Many marine species also use the lower salinity areas as nursery habitat during their juvenile stages of development. The majority of the important finfish and shellfish species are estuarine-dependent, using the estuarine areas during certain periods of their life cycle. These species generally spawn offshore in high salinity, temperature-stable waters. For most species spawning is protracted, but each species has peak spawning periods. After the eggs hatch, the organisms pass through a series of larval stages. The larval and postlarval stages migrate into the fertile, lower-salinity estuarine areas under the influence of tides and currents. The juveniles grow very rapidly during the spring and summer months, taking advantage of warmer temperatures, protection from predators, and the rich detrital food chain. The organisms generally begin to migrate offshore with the onset of cooler weather.

A.3.79. Commercially important freshwater fish in the study area include channel catfish, blue catfish, flathead catfish, yellow bullhead, carp, largemouth buffalo, smallmouth buffalo, alligator gar, spotted gar, longnose gar, bowfin, and freshwater drum. Red swamp crawfish are also harvested commercially in the wooded swamps and fresh marshes. Production of freshwater species is almost entirely from the Barataria Basin as little freshwater habitat remains in the Breton Sound Basin due to severe saltwater intrusion. Lac Des Allemands, in the Barataria Basin, supports a very productive catfish fishery. Between the years of 1963 and 1976, the average annual catch of catfish and bullheads was 1.3 million pounds. The annual value of this catch, based on 1977 exvessel (dockside) prices, was $447,000.

A.3.80. Freshwater sport fishing is popular in the fresh and intermediate waters of the study area. The primary species sought by anglers include largemouth bass, black crappie, white crappie, bluegill, redear

sunfish, warmouth, channel catfish, blue catfish, flathead catfish, and freshwater drum. Some sport crawfishing occurs in the wooded swamps and fresh marshes.

A.3.81. The majority of the commercial fisheries in the study area revolve around the estuarine-dependent finfish and shellfish species. Menhaden make up the largest total poundage with an average annual catch of 238 million pounds. For the years 1963-1978, the menhaden catch had an average annual value of $14 million. Menhaden are chiefly used for three products: fish meal, fish oil, and condensed fish solubles. Menhaden meal is used mainly as a source of protein in animal feeds. Menhaden oil is used for a number of industrial purposes including marine lubricants, plasticizers for the rubber industry, and oil for the paint industry. Menhaden solubles are used as a feed ingredient by nutritionists. The most valuable fishery in the study area are shrimp with an average annual value of $63.1 million reported for the years 1963-1978. This fishery involves primarily penaeid shrimp including brown shrimp, white shrimp, pink shrimp, and some seabobs. The American oyster supports the second most valuable commercial fishery with an average annual value of $25.6 million for the period 1963-1978. Other species of shellfish and finfish of commercial importance include both hardshell and softshell blue crabs, Atlantic croaker, spotted seatrout, sand seatrout, spot, and red drum. The average annual harvest and value of the major commercially important species in the study area are presented in table A-3-5.

A.3.82. A substantial amount of saltwater sportfishing occurs in the study area. Saltwater sportfishing includes not only finfish but sport shrimp trawling and sport crabbing, as well. The same shrimp species harvested commercially are caught by sport shrimpers. Sport crabbers catch primarily the blue crab. Popular finfishes sought by sport fishermen include spotted seatrout, sand seatrout, Atlantic croaker, spot, red drum, black drum, sheepshead, southern flounder, gulf flounder, southern

TABLE A-3-5

AVERAGE ANNUAL COMMERCIAL HARVEST AND
VALUE OF MAJOR ESTUARINE-DEPENDENT FISHERIES

Species	Breton Sound[b]	Barataria Bay	Total
Menhaden			
Harvest[c]	11.75	225.81	237.56
Unit price ($/lb)	$0.06	$0.06	-
Value[d]	0.70	13.55	14.25
Shrimp			
Harvest	7.04	23.23	30.27
Adjusted Harvest[e]	13.06	42.26	55.32
Unit price ($/lb)	$1.14	$1.14	-
Value	14.89	48.18	63.07
Oyster			
Harvest	2.50	4.05	6.55
Adjusted Harvest[f]	6.26	10.13	16.39
Unit price ($/lb)	$1.56	$1.56	-
Value	9.76	15.80	25.56
Croaker[g]			
Harvest	1.05	15.25	16.30
Unit price ($/lb)[h]	$0.23	$0.06	-
Value	0.24	0.92	1.16
Blue Crab			
Harvest	1.25	3.56	4.81
Unit price ($/lb)	$0.34	$0.34	-
Value	0.42	1.21	1.63
Seatrout[g]			
Harvest	0.36	2.70	3.06
Unit price ($/lb)[h]	$0.65	$0.18	-
Value	0.23	0.49	0.72
Spot[g]			
Harvest	0.01	2.88	2.89
Unit price ($/lb)[h]	$0.13	$0.05	-
Value	-	0.14	0.14
Red Drum			
Harvest	0.18	0.36	0.54
Unit price ($/lb)	$0.48	$0.48	-
Value	0.09	0.17	0.26
Total			
Harvest	24.14	277.84	301.98
Adjusted Harvest	33.92	302.95	336.87
Value	26.33		106.79

SOURCE: U. S. Department of Commerce, National Marine Fisheries Service. General canvas catch by water body and species for the years 1963-1978.

[a] Harvest refers to total recorded commercial catch of a particular species from an area. The catch from offshore waters was assigned to inshore areas based on the relative abundance of estuarine marsh habitat.

[b] Catch from Chandeleur and Breton Sounds was dissaggregated on the basis of estuarine marsh habitat and nursery grounds. A significant portion of that catch was landed in Mississippi, Alabama, and Florida.

[c] All harvest values in millions of pounds.

[d] Numbers are in millions of dollars (1983 prices). Value for all species except oysters represents a running average of 1974-78 exvessel prices brought to 1983 price levels using the CPI Food Index. For oysters, due to a typical data for the year 1975, the average price was calculated for the period 1976-80.

[e] Reflects 200 percent increase in reported inshore landings, based on surveys conducted by Louisiana Department of Wildlife and Fisheries (C.J. White, personal communication, letter dated April 23, 1979).

[f] Reflects 150 percent increase of reported landings, based on Mackin and Hopkins (1962) and Lindall et al. (1972).

[g] Includes food fish and industrial bottomfish. Quantities of croaker, spot, and seatrout calculated after Lindall et al. (1972).

[h] Average price in each basin based on proportion of annual catch used as food fish vs. industrial-fish.

kingfish, gafftopsail catfish, and Spanish mackerel. The area offshore supports a substantial sport fishery for species such as sharks, tarpon, black grouper, warsaw grouper, bluefish, cobia, crevalle jack, greater amberjack, pompano, dolphin, red snapper, gray snapper, vermilion snapper, tripletail, Atlantic spadefish, great barracuda, bonito, king mackerel, tuna, wahoo, sailfish, and blue and white marlin. Many of these offshore species prey heavily on a variety of estuarine-dependent species.

A.3.83. In addition to species of obvious commercial and recreational importance, the waters of the study area support rich populations of phytoplankton, zooplankton, benthos, macroinvertebrates, and numerous small fishes. These organisms are highly important from an ecological standpoint and are vital to the estuarine food web. Numerous genera of algae representing green, brown, blue-green, and red algae are present in the study area. Diatoms are the dominant phytoplankters in saline waters. Zooplankton in the area include copepods, cladocerans, protozoans, ostracods, decapod larvae, barnacle and copepod nauplii, insect larvae, larval fish, worms, rotifers, molluscan larvae, arrowworms, urochordates, cumaceans, isopods, and ctenophores. Benthic organisms include snails, crabs, clams, oysters, nematodes, harpacticoid copepods, amphipods, foraminiferans, polychaetes, oligochaetes, and ciliate protozoans. Free-swimming invertebrates include panaeid shrimp, blue crab, mantis shrimp, grass shrimp, seabobs, and squid. Small fishes common to the estuaries include mosquitofish, killifishes, anchovies, sheepshead minnows, and tidewater silversides.

RECREATION RESOURCES

A.3.84. Major recreational activities in the study area include fishing, hunting, boating, swimming, crabbing, shrimping, and camping. These recreational activities are supported on 1.7 million acres of land consisting of bottomland hardwoods, wooded swamps, marshes, and water.

For millions of Louisiana residents and out-of-state tourists, the area is a focal point for these activities. Coastal Louisiana is blessed with numerous lakes, bayous, bays, estuarine swamps, and marshes that provide an excellent environment for year-round recreational opportunities.

A.3.85. Recreational fishing is by far the most significant and heavily pursued activity in the area. In the 9-parish market area, 91,780 resident sport fishing licenses were issued in the 1979-1980 season. Most of the fishing is by boat. This use is reflected in the 81,492 motorboat registrations issued in 1980 for the market area and by the results of the 1980 Louisiana SCORP Demand Survey that indicated the high ranking participation from a boat. Crabbing and shrimping for recreational purposes are quite popular throughout the area although exact figures of users are unavailable.

A.3.86. Hunting activities are as varied as fishing types. Hunting for small game is the most prevalent and has a wider range of species and dependent habitat types available. Big game hunting is relegated to the freshwater habitats and is not as intensive as in more productive habitats such as bottomland hardwoods. Waterfowl hunting is the most well known hunting activity in the area although the demand is lower than for other hunting activities. For the 1979-1980 hunting season, 45,909 resident small game licenses and 23,716 resident big game licenses were issued in the 9-parish market area.

A.3.87. The primary users of the recreation resources are residents of southeast Louisiana. The 1979-1980 survey conducted by the Louisiana Department of Culture, Recreation and Tourism, Division of Outdoor Recreation, Office of Program Development, indicates that on a statewide average, 81.7 percent of boat fishing activity occasions and 86.6 percent of the small game hunting activity occasions occur within 45 miles from the participant's residence.

A.3.88. Recreation lands and facilities in the coastal area are categorized by use as private, public, or commercial. Commercial facilities serve the public on a fee basis. Public facilities available include boat launching ramps, small marinas, and local parks and campgrounds. In addition, there are several Federal Wildlife Refuges in the area with a total of 75,333 acres and several State Wildlife Management Areas with a total of 211,045 acres. A summary of existing recreational facilities in the market area are shown in table A-3-6.

A.3.89. Although there is a great potential for recreation in the study area, several limiting factors have prevented coastal Louisiana from being used to the fullest potential. Access to many areas suitable for recreation is inadequate. The coastal Louisiana wetlands follow the shoreline and extend up to 90 miles inland. Therefore, landward access for recreation is difficult and access by water is dictated. The number of available boat ramps is not adequate to meet the demand of potential users. Many existing facilities are not developed to their full potential and are often concentrated in areas where road access is limited. Many coastal wetlands are privately owned and public use as well as access to other wetlands and shores is prohibited.

A.3.90. Other limiting factors that affect recreation use include the competition between commercial and recreation interests for the same resources. Since land access is limited by the physical environment, areas that could be used for recreation must vie with industrial and residential uses. The competition often results in congested strip development that aggravates the problem of accessibility for the recreationists.

CULTURAL RESOURCES

A.3.91. The study area has a rich cultural heritage, a result of the diversity and abundance of natural resources and the strategic

TABLE A-3-6

EXISTING RECREATION FACILITIES INVENTORY

Parish	Boat Launching Lanes	Other Amenities
Jefferson	25	5 picnic tables 51 trailer camping spaces 2 fishing piers
Lafourche	35	43 picnic tables 35 trailer camping spaces 14 tent camping sites 5 fishing piers 52,656 hunting acres
Orleans	29	394 trailer camping spaces 2 fishing piers 2 yacht harbors
Plaquemines	14	19 picnic tables 174,000 hunting acres
St. Bernard	21	125 trailer camping spaces 75 tent camping sites 39,583 hunting acres
St. Charles	10	2 picnic tables 33,000 hunting acres
St. John the Baptist	4	12 picnic tables 15 trailer camping spaces 8,325 hunting acres
St. Tammany	15	365 picnic tables 942 trailer camping spaces 362 tent camping sites 2 fishing piers Bike, Horseback, and Nature Trails - 5 miles 26,716 hunting acres
Terrebonne	18	62 picnic tables 85 trailer camping spaces 50 tent camping sites 29,000 hunting acres

importance of Mississippi River trade and commerce. Historical settlement on the Mississippi River banks has been intensive since the early 1700's.

A.3.92. Numerous archeological sites have been identified. The sites include early settlements, earth and shell middens, forts, historic shipwrecks, structures, and aboriginal sites. These resources date back to the earliest exploration and settlement and represent the various stages in the area's history. An historical atlas of shipwrecks in the Mississippi River, prepared by Dr. Randall A. Detro and Donald W. Daven, Nicholls State University, Thibodaux, Louisiana, shows that from 1814 to 1979, between Baton Rouge and the delta, there were 793 documented sinkings. Approximately 40 percent of these vessels were lost between Algiers (river mile 94.0) and Harahan (river mile 107.5).

A.3.93. The National Register of Historic Places as published in the Federal Register dated 6 February 1979 and in the weekly supplements through 9 February 1982 were consulted and the historic sites noted. In the Barataria Basin, eight properties are presently listed in the National Register of Historic Places, five properties have been determined eligible for listing in the Register, and one property has been nominated to the Register. All but one of these properties, the Bayou Des Coquilles Archeological site, are historic resources. The properties include historic forts, plantation houses and other residences, a courthouse, and a church. All the National Register properties except Fort Livingston are located on natural levees of the Mississippi River and its distributaries. Fort Livingston is located at the mouth of Barataria Bay on the western tip of Grand Terre Island.

A.3.94. Breton Sound contains two properties listed in the National Register of Historic Places. Both properties are historic forts, Fort de la Boulaye and Fort St. Phillip, located along the Mississippi River natural levee.

A.3.95. Over 230 archeological sites are located in the area. The most common archeological sites are shell middens. Middens are concentrations of various kinds of refuse built up over a period of years and represent the garbage of the prehistoric occupants of the site. Predominant components of the middens are the shells of two species of shellfish, oyster and *Rangia cuneata*. Extensive investigations have shown that some middens represent habitation sites while others were special collection stations. Midden sites are spread over the entire study area and throughout the marsh. Beach deposits are a common form of midden. These sites are inundated shell middens on a present beach that have been disturbed and reworked by wave action.

A.3.96. Earthen mounds are relatively rare in the study area. Mounds of various sizes were constructed to serve either as special burial tumuli or as foundation for special ceremonial structures, or for both purposes.

Section 4. FUTURE CONDITIONS

A.4.1. The most probable future conditions if no Federal action is taken are determined by projecting conditions that will prevail in the area over the planning period 1980 to 2035. Based on available information, these conditions are described in the following paragraphs.

HUMAN RESOURCES AND ECONOMY

A.4.2. Population in the 12-parish economic study area is expected to increase from 1,522,500 in 1980 to 2,211,000 in 2035. The population projections are shown in table A-4-1. The classic pattern of regional urbanization is expected to continue with the population concentrating around the New Orleans Metropolitan Area.

A.4.3. The New Orleans Metropolitan Area is expected to have the largest increase in population and will maintain a significant share of the population in the future.

A.4.4. Per capita income in the area is expected to triple during the period 1985-2035. Plaquemines Parish is estimated to have the highest per capita income with an annual growth rate of 7.3 percent. The next highest per capita income is anticipated to occur in the New Orleans SMSA, with a growth rate of 5.9 percent, followed by St. Charles, St. James, and Terrebonne Parishes with annual growth rates of 5.2 percent, 7.2 percent, and 5.5 percent, respectively. Per capita income projections are shown in table A-4-2.

A.4.5. Employment in the area in 1978 was primarily in the Retail and Wholesale Trade sector, with nearly 150,000 people. The Service sector employed 134,000 and Government provided jobs for 102,000 individuals. In 1970, these three sectors employed 110,000, 102,000, and 78,000, respectively. Between 1970-1978, however, the Construction sector grew

TABLE A-4-1

POPULATION PROJECTIONS[1/]

	1985	1995	2005	2015	2025	2035
New Orleans SMSA[2/]	1,212,000	1,324,000	1,420,000	1,505,000	1,591,000	1,677,000
Ascension[3/]	52,000	59,000	65,000	69,000	73,000	78,000
Assumption[4/]	22,000	24,000	25,000	26,000	27,000	28,000
Lafourche[4/]	85,000	95,000	102,000	108,000	114,000	120,000
Plaquemines[4/]	27,000	28,000	29,000	30,000	30,000	31,000
St. Charles[4/]	39,000	45,000	49,000	53,000	56,000	60,000
St. James[4/]	22,000	23,000	24,000	24,000	25,000	26,000
St. John[4/]	33,000	38,000	41,000	44,000	47,000	50,000
Terrebonne[4/]	98,000	109,000	118,000	126,000	134,000	141,000
TOTAL: Study Area	1,590,000	1,745,000	1,873,000	1,985,000	2,097,000	2,211,000

1/ All future population estimates are based on 1980 Obers projections, using the low change in share scenario. A straight line interpolation was used to determine the 10-year increments.

2/ The interpolation to required years was the only modification to the data for the New Orleans SMSA.

3/ Ascension Parish was regressed against the total Baton Rouge SMSA, using census data from 1960, 1970, and 1980. The coefficients produced were applied to the interpolated OBER's projections of the Baton Rouge SMSA to provide the estimate of Ascension Parish future population.

4/ The remaining seven parishes were regressed against the non-SMSA portion of BEA 113, using census data from 1960, 1970, and 1980. The coefficients produced were applied to the interpolated OBER's projections of BEA 113, less the two SMSA's, Gulfport/Biloxi and New Orleans, to provide the estimate of future population for each parish.

	1985	1995	2005	2015	2025	2035
New Orleans SMSA 2/	14,000	19,000	25,000	31,000	36,000	41,000
Ascension 3/	11,000	14,000	18,000	23,000	27,000	30,000
Assumption 4/	11,000	16,000	21,000	27,000	33,000	38,000
Lafourche 4/	12,000	16,000	21,000	26,000	31,000	35,000
Plaquemines 4/	15,000	22,000	29,000	39,000	47,000	55,000
St. Charles 4/	13,000	16,000	20,000	26,000	30,000	34,000
St. James 4/	13,000	19,000	25,000	33,000	40,000	47,000
St. John 4/	10,000	13,000	16,000	21,000	24,000	27,000
Terrebonne	13,000	17,000	21,000	27,000	32,000	36,000

SOURCE: 1980 OBERS BEA Regional Projection, Volume 8, Region 5, Southeast US Department of Commerce, Bureau of Economic Analysis.

1/ All future per capita income projections were based on 1980 Obers projection of personal income and population, using the low change in share scenario. A straight line interpolation was used to derive the 10-year increments presented.

2/ The interpolated income projections divided by the interpolated population projections are presented as the projected per capita income for the New Orleans SMSA.

3/ The proportion of the Baton Rouge SMSA personal income earned in Ascension parish, calculated from data in BEA's Local Area Personal Income 1969-1974 and 1971-1976, was applied to the interpolated personal income projections for Baton Rouge SMSA, to estimate future personal income earned in Ascension Parish. These projected incomes divided by the projected populations, table A-4-1, are presented as per capita income projections for the indicated years.

4/ The proportion of the non-SMSA portion of BEA 113 personal income earned in each of the remaining seven parishes, calculated from data in BEA's Local Area Personal Income 1969-1974 and 1971-1976, was applied to the interpolated personal income projections for the non-SMSA portion of BEA 113, to estimate future personal income earned in each parish. These projected incomes divided by the projected population, table A-4-1, are presented as per capita income projections for the indicated years.

at the fastest rate, from 30,000 to 50,000. The Trade sector experienced the second largest amount of growth, increasing by 35 percent from 1970 to 1978. The Service and Government sectors followed with increases of 31 percent in employment during the same period. Although no employment projections were made for the study area, it is expected that future trends will not differ substantially from historical trends. Growth is expected to be concentrated in and around the New Orleans Metropolitan Area. Other parishes outside the metropolitan area that are expected to experience significant employment growth are Lafourche and Plaquemines Parishes. These parishes are all endowed with central transportation infrastructure and, for the most part, ample supplies of water.

A.4.6. Employment in the commercial fisheries industry in the area in 1980 was estimated at 3,000 full-time and 10,000 part-time fishermen. Over the 25-year period from 1950 to 1975, the National Marine Fisheries Service has estimated that the number of full-time commercial fishermen in coastal Louisiana has remained fairly stable, growing at less than 1 percent annually. In view of the projected decline in marsh productivity, there is little evidence to suggest any significant growth in the numbers of persons able to earn their entire living as commercial fishermen. The part-time fishermen may well increase in numbers due to reclassification of former fulltime fishermen and increases in large-scale recreational fishermen who sell portions of their catch. However, the dwindling resource base leads to the conclusion that the total man-hours spent in commercial fishing will decline.

LAND RESOURCES

A.4.7. The land resources are expected to continue historical trends that would result in further reductions in areal extent and diversity by the year 2035. The primary forces shaping the land are the natural process of deterioration and man's activities. The natural processes of

:rosion, subsidence, and a general rise in sea level are expected to :ontinue to effectively reduce the land mass. Studies indicate that the ;ulf shoreline will probably continue to retreat at an average rate of .6 feet per year. Based on historical subsidence and sea level trends, :he relative elevation of land and water surfaces is expected to change)y approximately 0.5 foot by 2035 (Gagliano et al., 1970). Further leterioration of the barrier islands will increase the intensity of wave ıttack on the organic marsh soils. The increase in water depth and ;urface area will accelerate saltwater encroachment and erosion. The :umulative effect of these changes will be to convert 280,900 acres of aarsh to open water by the year 2035. This will cause substantial :hanges in the diversity of land types.

\.4.8. In addition to natural losses, activities of urbanization and Industrialization are expected to affect the wetlands. As population ınd industrial activity in the study area increase, there will be an ıncreased conversion of forest, agricultural lands, and, to a lesser ›xtent, marshes to urban, suburban, and industrial uses. Much of the Land converted to these uses will be adjacent to the natural levees of :he Mississippi River. The exploitation of area resources will require iredging of canals and channels that contribute directly to wetlands Loss.

VATER RESOURCES

\.4.9. Water quality will be affected by changes in population and Industrial activities that are expected to increase significantly in the ırea. Advances in industrial materials recovery processes and continued ıpplication of discharge permit restrictions should encourage industries :o discharge generally cleaner effluents. Wastewater discharges from nunicipalities, industries, and vessels are expected to markedly Increase. The State of Louisiana recently intensified discharge permit monitoring and enforcement efforts. This effort will probably help slow

ıe Barataria and Breton Sound Basins, respectively, by the year

.6. The natural expansion of water bodies, caused by subsidence and .on, is being accelerated by man's activities. Dredging numerous .s has increased the water surface area. The length of the shore- affected by tides and waves has also increased exposing even more ı to saltwater intrusion and wave attack. The marsh soils are .y eroded by wind-driven waves and wave wash from boat traffic. : factors have contributed to the increased width of canals. The ıl increase in canal width has been estimated at 2 to 5 percent per (Craig et al., 1978). Thus, there is a need to reduce the rate of ısion of the water bodies.

.7. The enlargement of surface area and tidal storage volume of the · bodies has been accompanied by an increase in salinity. Although ·term salinity data is extremely sparse and generally obtained from .ons located along major navigation channels, changes in salinity ›e deduced from shifts in plant communities. The plant communities ıe area were subdivided into four marsh types, fresh, intermediate, .ish, and saline, on the basis of their tolerance to salt (Chabreck, ı. Studies indicate that the saline marsh increased in average ı from 5.8 to 7.9 miles, moving inland 2.1 miles over a 25-year ›d (U. S. Army Corps of Engineers, 1970). Similarly, the brackish ı increased in average width from 6.6 to 8.3 miles and was pushed ıd an average of 3.8 miles. Saltwater encroachment into the .ries is expected to continue in the future.

.8. Opportunities exist for improving the water resources. Aggres- enforcement of regulations governing wastewater discharges would .ficantly improve water quality. Saltwater encroachment could be :ed by placing a system of barriers and weirs. Finally, introducing ıwater would flush the estuaries, thereby improving water quality ·educing saltwater intrusion.

open water areas with dredged material to create new marsh, construct saltwater barriers, and introduce freshwater and sediment to enhance vegetative growth.

WATER RESOURCES

A.5.13. Water quality in the estuarine marsh area is influenced, to some extent, by municipal and industrial wastewater discharges and agricultural runoff. The shallow lakes in the upper portion of the basins are characterized as hypereutrophic. This condition is due to the high nutrient content of the bayous and canals that enter the lakes. The lakes also have low DO content and high concentrations of herbicides. The high content of nutrients and herbicides is the result of agricultural operations along the margins of the wetlands. The low DO conditions are generally due to municipal and stormwater discharges and the lack of freshwater inflows to the water bodies. The high content of nutrients frequently causes extensive algal blooms.

A.5.14. Water bodies in the lower basin are characterized as mesoeutrophic. The quality of these waters is generally better due to the ebb and flow of the tides and the estuarine conditions in the shallow lakes and bays. There is a need to improve the low DO and high concentrations of nutrients and herbicides. The rapid urbanization and industrialization in the area will increase the wastewater discharge into the area's water bodies. Water quality in the area is, therefore, expected to decline in the future. Thus, there is a need to improve water quality.

A.5.15. The water bodies in the area are expanding rapidly due to the combined effects of subsidence, erosion, and a general rise in sea level. As a result of these forces, the surface area of water bodies in the Barataria and Breton Sound Basins increased by approximately 130,800 and 32,200 acres, respectively, between 1956 and 1978. The surface area of the water bodies is expected to increase by 220,700 and 60,200 acres

TABLE A-5-3

ACREAGE CHANGES IN SELECTED HABITAT TYPES

1956 to 1978

Area	Brackish & Saline Marsh		Fresh and Intermediate Marsh		Bottomland Hardwoods & Wooded Swamp Forest	
	1956	1978	1956	1978	1956	1978
Barataria Basin	229,600	269,200	303,100	196,600	65,000	213,300
Breton Sound Basin	186,900	177,800	37,300	13,600	51,500	10,500
TOTAL	416,500	447,000	340,400	210,200	116,500	223,800

SOURCE: Modified after US Fish and Wildlife Service (1980).

area are retreating steadily. The deltaic masses have retreated at rates of 13.7 to 16.2 feet per year resulting in land loss rates of 1,670 (2.6 square miles) to 2,083 (3.3 square miles) acres per year prior to 1960 (Craig et al., 1978).

A.5.11. Land loss has been accelerated by the construction of numerous canals for navigation, drainage, and exploitation of renewable and non-renewable resources. A total of 71.2 and 12.9 square miles of canals had been dredged in the Barataria and Breton Sound Basins, respectively, by 1970 (Gagliano et al., 1973). These canals have lengthened the tidal shorelines 1,557 and 561 miles in Barataria and Breton Sound Basins, respectively (Becker, 1972). Because of the canals, saltwater has invaded further inland and wave attack on the weak marsh soils, especially from boat wash, has increased. A subsequent study of land loss in the Barataria Basin showed that the percentage of canal area to total marsh area had increased from the 0.9 percent reported in the Gagliano study to 2.6 percent in 1976 (Craig et al., 1978). The study also indicated that the rate of marsh loss in the Barataria Basin was accelerating and had increased about 2.7 times to between 3,200 (5 square miles) to 7,400 (11.6 square miles) acres per year for the period 1960 to 1974.

A.5.12. The cumulative effect of natural processes and man's activities has drastically reduced the land mass and habitats available for wildlife. Table A-5-3 displays acreage change in selected habitat types in the Barataria and Breton Sound Basin for the years 1956 to 1978. The habitat types critical to fish and wildlife are expected to decline further by the year 2035. Barataria and Breton Sound Basins are expected to lose approximately 220,700 and 60,200 acres of marsh each by the year 2035. It is apparent that there is a need to reduce the rate of land loss and restore or maintain the viability of wetlands habitats. There are several possible opportunities to partially reduce the rate of land loss: regulate the alteration of other marshes, fill

A.5.8. There is a need to stabilize the commercial fisheries and wildlife industries. Enhancing habitat conditions will help to stabilize the industries and improve productivity in the fish and wildlife resources. There are several opportunities for enhancing habitat conditions including establishing sanctuaries, improving fish and wildlife management practices, regulating the alteration of wetlands, filling open water areas with dredged material to create marsh, placing barriers to reduce saltwater intrusion, and introducing freshwater.

LAND RESOURCES

A.5.9. Louisiana contains approximately 41 percent of the coastal wetlands in the contiguous United States (Turner and Gosselink, 1975). Studies in 170 indicated that coastal Louisiana was experiencing a net land loss of 16.5 square miles per year (mi^2/yr) (Gagliano and Van Beek, 1970). In 1980, studies revealed that the rate of marsh loss has significantly increased and is estimated to be 39 square miles per year (Wicker, 1980). Plate A-4 depicts the areas and severity of land loss in coastal Louisiana from 1955 to 1978. Marsh loss rates range from low (0-1 acres per mi^2/yr) to very severe (>4 acres per mi^2/yr). Recent marsh loss rates for the Barataria and Breton Sound Basins are estimated at 7.7 and 2.3 mi^2/yr, respectively.

A.5.10. The land loss is the result of a combination of natural processes and man's activities. Formerly, the Mississippi River migrated back and forth across coastal Louisiana developing a series of deltas. This process formed a deltaic plain that extended the landmass gulfward. Each year, the river would overflow the study area and deposit a layer of sediment. The influx of sediments maintained the growth of the land mass. When the river was leveed off to provide flood protection to development, sedimentation in the area ceased. Deprived of the annual sediment inputs, the forces of deterioration dominated the area. The result was compaction, subsidence, and erosion. The shorelines in the

A.5.6. The closing of many of the fishery processing plants has been linked to the processor's inability to obtain a steady supply of fish stocks. The fish harvest has varied widely from year to year. Presently, the commercial fisheries harvest averages 337 million pounds per year with an exvessel value of approximately $107 million. With a projected decline in habitat conditions, the fisheries harvest is expected to decline to 183 million pounds and the value to about $63 million by the year 2035. Thus, there is a need to stabilize the fisheries harvest. Stabilizing will give the fisheries processing industry an opportunity to concentrate on expanding their market area.

A.5.7. Similar trends of declining employment and catch can be detected in the commercial wildlife industry. Although the number of trappers nearly tripled during the 1970's, the number of pelts and pounds of meat taken has declined by nearly 65 percent. Table A-5-2 displays the trend in trapping licenses, pelts, and pounds of meat.

TABLE A-5-2

LOUISIANA TRAPPING LICENSES, PELTS, AND POUNDS OF MEAT

	Licenses	Pelts	Pounds of Meat
1970	4,444	3,002,047	10,480,000
1971	3,398	2,097,761	8,770,000
1972	2,761	1,732,682	8,970,000
1973	4,741	2,180,332	11,300,000
1974	6,295	2,304,916	12,550,000
1975	7,528	2,033,379	10,430,000
1976	6,404	2,533,500	11,136,000
1977	9,573	3,246,988	3,635,000
1978	12,069	2,635,001	3,698,000
1979	11,106	1,964,937	2,984,379

SOURCE: Johnny Tarver, Fur and Refuge Division, Louisiana Department of Wildlife and Fisheries.

TABLE A-5-1

LOUISIANA FISHERIES WHOLESALERS AND PROCESSING PLANTS

Year	Wholesale Plants	Processing Plants		
		Canned Fishery Products Plants	Industrial Fishery Products Plants	Others
1970	113	-	-	110
1971	51	19	29	136
1972	105	19	28	84
1973	108	18	22	81
1974	99	17	23	87
1975	101	16	19	75
1976	98	13	18	76
1977	91	12	24	73
1978	115	10	25	101
1979	115	10	21	96

SOURCE: Fisheries of the United States, 1971 through 1980, National Marine Fisheries Service, U. S. Department of Commerce.

Section 5. PROBLEMS, NEEDS, AND OPPORTUNITIES

HUMAN RESOURCES

A.5.1. Employment in the commercial fisheries and trapping industries has varied considerably due to changing market conditions and the availability of locally produced fish and wildlife resources. The most dramatic shifts in employment have been in the commercial fisheries industry.

A.5.2. During the period 1970-1979, the number of processing plants and the amount of seasonal and yearly employment showed a general declining trend. Employment has varied considerably from year to year.

A.5.3. The number of processing plants and employment fluctuated from year to year within relatively narrow limits in the early 1970's, a 4-percent range. However, the number of plants and the employment fluctuated as much as 25 percent from year to year in the late 1970's.

A.5.4. Similar trends can be detected in the canned seafood and industrial fishery processing industry. The number of wholesalers and canneries has varied considerably, but overall there has been a slight increase. Table A-5-1 shows the number of fisheries wholesalers and processing plants.

A.5.5. In the processing plants category, the number of canned fisheries product plants has decreased by 47 percent. The number of industrial fishery product plants has decreased by 28 percent. This decrease has resulted in the loss of jobs and has diminished the processor's capability to meet the population demand. Fisheries products have had to be imported to meet the increasing demand.

RECREATION RESOURCES

A.4.17. Recreation demands are expected to significantly increase in the future. Hunting needs are estimated to increase from 2,595,530 man-days in 1985 to 4,526,597 man-days by 2035. The need for boat launching lanes is expected to increase from 1,050 lanes in 1985 to 1,587 lanes by 2035. Population growth and associated industrial development will increase the competition between commercial and recreation interests for the same resources.

A.4.18. The continued loss of productive coastal marsh fish and wildlife habitat will adversely affect future opportunities for fishing and hunting. The opportunities for hunting will decrease directly with the loss of marsh. While fishing will not be subjected to a shrinking resource base, the activity will suffer qualitatively as the marsh types on which fishing productivity depends are destroyed. This loss to fishing and hunting is valued at $558,000 annually.

CULTURAL RESOURCES

A.4.19. In the future, the destructive forces of erosion, wavewash, saltwater intrusion, and subsidence will continue to attack and destroy cultural resources in the marshes. Cultural resources located along the natural levees of the river will continue to be adversely affected by urban and industrial development.

A.4.15. The loss and alteration of habitat types would adversely affect the productivity of both wildlife and fishery resources. Due to the relationship between total marsh acreage and fishery production, there would be substantial declines in populations of finfish and shellfish species. As wetlands are lost, saltwater intrudes through the open water created by the loss of vegetation, by canals and channels, erosion, and subsidence. Increased salinity enlarges the saline marshes at the expense of the highly productive brackish marshes. Continued saltwater intrusion would be particularly harmful to the American oyster due to it's immobility. The oyster would be subjected to increased predation by the southern oyster drill and other serious oyster predators. Higher salinities are also conducive to infection caused by the fungus *Labyrinthomyxa marina*, especially at higher temperatures. This fungus is capable of causing widespread oyster mortalities. The average annual harvest of commercial fisheries is valued at approximately $100 million for the period 1963-1978. The continued reduction in fisheries habitat will cause a reduction in the value of the harvest. It is estimated that the harvest value in 2035 will represent only 58 percent of the 1980 harvest value.

A.4.16. Wildlife productivity would decline due to both direct loss of habitat and conversion of habitats to more saline types. Fresh/intermediate marsh areas provide more favorable habitat for furbearers, waterfowl, and the American alligator. As a result of direct habitat loss and the trend toward increasingly saline habitats, the average annual harvest of furbearers would be reduced by over $400,000. The commercial wildlife average annual harvest for the period 1940-1976 was valued at over $6.2 million dollars. Increased saltwater intrusion would damage the revived commercial alligator industry, valued at approximately $2 million in 1980.

TABLE A-4-4

HABITAT ACREAGE BY TYPE

Breton Sound Basin

Habitat Type	1978	1985	1995	2005	2015	2025	2035
Bottomland Hardwoods	9,500	8,500	7,300	6,300	5,400	4,700	4,000
Wooded Swamp	1,000	900	800	700	600	500	400
Marsh							
Fresh/Intermediate	13,600	11,100	8,300	6,200	4,600	3,400	2,600
Brackish	131,000	130,500	128,300	125,000	121,000	116,500	111,700
Saline	46,800	41,300	34,600	29,000	24,300	20,400	17,100
Total	191,400	182,900	171,200	160,200	149,900	140,300	131,400
Water Bodies							
Fresh/Intermediate 1/	3,800	3,200	2,500	2,000	1,600	1,300	1,100
Estuarine 2/	329,700	339,000	351,400	362,900	373,600	383,500	392,600
Total	333,500	342,200	353,900	364,900	375,200	384,800	393,700
Other Lands 3/	131,400	132,400	133,600	134,700	135,700	136,500	137,300
Total	666,800	666,800	666,800	666,800	666,800	666,800	666,800

SOURCE: Modified after US Fish and Wildlife Service (1980).

1/ Includes water bodies with salinities of less than 5 parts per thousand (ppt).

2/ Includes water bodies with salinities 5 ppt or greater.

3/ Includes lands cleared and converted to agriculture, pasture, residential, urban, and industrial areas.

TABLE A-4-3

HABITAT ACREAGE BY TYPE

Barataria Basin

Habitat Type	1978	1985	1995	2005	2015	2025	2035
Bottomland Hardwoods	43,500	39,900	35,400	31,400	27,800	24,600	21,800
Wooded Swamp	169,800	155,900	138,200	122,500	108,600	96,200	85,300
Marsh							
Fresh/Intermediate	196,600	164,000	126,600	97,600	75,300	58,100	44,800
Brackish	111,700	114,400	113,400	108,500	100,900	91,800	81,900
Saline	157,500	152,000	144,600	137,600	130,800	124,400	118,400
Total	465,800	430,400	384,600	343,700	307,000	274,300	245,100
Water Bodies							
Fresh/Intermediate 1/	70,500	71,700	73,300	74,700	76,000	77,100	78,100
Estuarine 2/	578,000	612,300	656,500	696,000	731,000	763,000	791,200
Total	648,500	684,000	729,800	770,700	807,000	840,100	869,200
Other Lands 3/	304,900	322,300	344,500	364,200	382,100	397,300	411,100
Total	1,632,500	1,632,500	1,632,500	1,632,500	1,632,500	1,632,500	1,632,500

SOURCE: Modified after US Fish and Wildlife Service (1980).

1/ Includes water bodies with salinities of less than 5 parts per thousand (ppt).

2/ Includes water bodies with salinities 5 ppt or greater.

3/ Includes lands cleared and converted to agriculture, pasture, residential, urban, and industrial areas.

narrow to 14 miles apart in the 10-percent drought year. The inward movement of the isohalines and the narrowing of the 5-15 ppt band indicate that the fresh, intermediate, and brackish marshes, which are the most productive for fish and wildlife, will decrease.

BIOLOGICAL RESOURCES

A.4.13. The deterioration in habitat conditions is expected to continue the historical trend and adversely affect the fish and wildlife resources. The quality and quantity of habitat is being affected by the natural processes of compaction, subsidence, erosion, and saltwater intrusion, and by man's activities. The activities of man that will continue to contribute to habitat deterioration include dredging and filling operations, and urban expansion. The combined effects of these activities and natural processes will be conversion of valuable productive wetlands to open water. The marsh is also expected to experience a loss of 280,900 acres by the year 2035, a 42 percent reduction in total marsh acreage. Marsh loss in the Barataria Basin would be 220,700 acres and marsh loss in the Breton Sound Basin would be 60,200 acres, a loss of 47 and 31 percent, respectively. The highest rate of marsh loss would occur in the fresh/intermediate marsh. The Barataria Basin would experience a 77 percent loss of fresh/intermediate marsh and loss of this marsh type in the Breton Sound Basin would be 81 percent by year 2035.

A.4.14. Bottomland hardwoods in the study area would be reduced from 52,949 to 25,849 acres, a loss of 51 percent. This loss would be due primarily to agricultural, industrial, and urban development. Wooded swamps would be reduced from 170,780 to 85,723 acres, a loss of 50 percent. Some wooded swamps would be drained and used for other purposes and some would be killed by saltwater intrusion. Tables A-4-3 and A-4-4 present the anticipated changes in habitat types for future conditions without the project for the Barataria and Breton Sound Basins, respectively.

the degradation of existing water quality. However, current economic pressures may force Federal agencies to be less aggressive in their efforts to meet the objective of the Federal Water Pollution Control Act of 1972. Therefore, substantial improvement in the overall quality of study area waters is not anticipated in the foreseeable future.

A.4.10. The water surface area is expected to increase by 280,900 acres by the year 2035. This change is due to erosion and subsidence of land, a general rise in sea level, and saltwater encroachment.

A.4.11. Saltwater encroachment is expected to continue the historical trend, resulting in increased salinities throughout the area in the future. The degree of salinity increase depends on numerous variables that include loss of freshwater and sediment inputs, compaction, subsidence, and erosion of the land mass, and channel and canal dredging. Continued increases in salinity will decrease the large zone of brackish water and marshes. Increased saltwater encroachment will continue to enlarge the saline marshes at the expense of the brackish, intermediate, and fresh marsh types.

A.4.12. A hydrologic analysis was performed by adjusting historical salinity data to determine the average 1980 position of the 5 ppt and 15 ppt isohalines in the Barataria and Breton Sound Basins. The predicted movement of these isohalines for a 10-percent drought condition is shown on plate A-3. In the Barataria Basin, the 5 and 15 ppt isohalines are estimated to move inland about 7 and 12 miles, respectively. The 5 and 15 ppt isohalines in the Breton Sound Basin are expected to move inland about 2 and 17 miles, respectively. Not only are the isohalines moving inland, but the width between the 5 and 15 ppt isohaline lines is estimated to decrease. The width between the 5 and 15 ppt in Breton Sound was 21 miles in 1980 but is expected to narrow to 7 miles in the 10-percent drought year. In 1980, the 5 and 15 ppt isohalines in the Barataria Basin were 19 miles apart but the distance is expected to

HABITAT DETERIORATION

A.5.19. Habitat losses have occurred as a result of natural processes and man's activities. The natural processes of subsidence, compaction, and erosion have converted large areas of coastal marshes to open water. Man's activities have accelerated the marsh losses. The man-made alterations have virtually eliminated the historical processes of overbank flooding and distributary flow, depriving coastal wetlands of the fresh water, nutrients, and sediments vital to their continued existence. Activities associated with dredging also cause direct marsh losses and provide avenues for saltwater to intrude into the marshes.

A.5.20. As saltwater intrudes into a fresher area, the vegetation in the area is gradually killed. Before more saline-tolerant plant species can revegetate, open water areas are often created because the root systems of the original vegetation that helped to hold the marsh substrate together have been lost. The greatest damage to marsh plants in coastal Louisiana occurs when fresh marshes with highly organic soils are subjected to much greater water salinity and strong tidal action. Plants in these areas are killed by elevated water salinity and the organic substrate becomes loose and disorganized without the stabilizing effect of plant roots. When this occurs, organic soils are flushed from the affected areas and open ponds and lakes replace emergent marsh (Chabreck, 1981). As marsh is lost and open water areas are created, the total area of interface between the water and marsh is increased, leading to increased erosion. The marsh remaining in the areas affected by saltwater intrusion is more saline than the original marsh. In general, land loss and saltwater intrusion create an ever-increasing cycle of wetland deterioration, with increased saltwater intrusion causing increased land loss and vice versa.

A.5.21. The construction of major navigation channels has resulted in the direct loss of habitat due to channel excavation and dredged material disposal areas. These large channels also allow increased erosion and saltwater intrusion. Following construction of the MR-GO in the late 1950's and early 1960's, salinities in the wetlands of St. Bernard Parish increased three-fold, converting larger acreages of fresh marsh to open water and more saline marsh types and eliminating certain areas of wooded swamp. Large areas of fresh marsh have been lost or altered in the Barataria Basin since the construction of the Barataria Bay Waterway.

A.5.22. The reality of saltwater intrusion can be observed by inspecting plates A-5 and A-6. Plate A-5 shows the approximate boundaries between fresh and nonfresh marshes in the Mississippi Deltaic Plain region in the 1950's. The nonfresh marshes shown on this map include intermediate, brackish, and saline marshes. Plate A-6 shows the approximate boundaries of fresh, intermediate, brackish, and saline marsh types in the same region in 1978. The extent of the inland shift can be observed by comparing the boundary between the fresh and nonfresh marsh on the 1950 map with the boundary between the fresh and intermediate marshes on the 1978 map. There has also been an inland shift of the brackish-saline marsh boundary. Chabreck (1970) indicated a 2-mile landward movement of the saltwater-brackish marsh boundary since the 1940's. Additional information substantiating saltwater intrusion is demonstrated by the inland extension of oyster leases. Plates A-7 and A-8 show the distribution of oyster leases in the Barataria Bay area in 1959 and 1975 (Van Sickle et al., 1976). By 1975, a significant area in the lower half of Little Lake had been leased. In reviewing these plates, it should be noted that the inland shift in leases occurred primarily because the gulfward leases became too saline for oyster growth. Many of the gulfward leases are inactive and unproductive. The expanded lease areas were previously too fresh for oyster growth, but because of continued saltwater encroachment these areas are of the

appropriate salinity for oyster production. (The effect of salinity changes is discussed further in paragraph A.5.30 of this appendix.) It is interesting to note that in 1898 Bayou St. Denis and Grand Bayou, which connect Barataria Bay to Little Lake, were almost constantly fresh and harbored a continuous population of large-mouth bass (Moore and Pope, 1910).

A.5.23. Wildlife. The combined effects of land loss and saltwater intrusion have resulted in severe adverse impacts on valuable wildlife resources. These losses are expected to continue in the future. Reduced habitat has led to decreased wildlife populations including resident and migratory waterfowl, wading birds, shorebirds, furbearers, and a variety of small and big game animals. The losses have led to decreased commercial fur harvests and reduced opportunities for waterfowl, big game, and small game hunting. Louisiana's vast wetlands provide wintering habitat for over two-thirds of the Mississippi Flyway waterfowl, as well as other migratory game birds including rails, gallinules, and snipe (Bellrose, 1976). According to the Louisiana Department of Wildlife and Fisheries, over $25 million is spent on waterfowl hunting each year.

A.5.24. Saltwater intrusion has caused drastic changes in plant and animal communities. Fresh/intermediate marshes have been converted to more saline types and some areas of wooded swamp have been entirely eliminated. These changes in habitat types have seriously altered the structure of wildlife communities. As fresh/intermediate marshes have been converted to more saline types, valuable waterfowl and furbearer habitat has been eliminated.

A.5.25. An area partially located in the Breton Sound Basin, which the U. S. Fish and Wildlife Service refers to as the Delacroix Unit, was once considered to be Louisiana's most productive waterfowl marsh area. The Delacroix Unit now supports the smallest population of all

the key wetland areas in Louisiana. Prior to construction of the MR-GO, the area supported over 250,000 waterfowl. Between 1969 and 1978, this unit supported an average annual population of only 19,200 wintering waterfowl. The radical decrease in wintering waterfowl in the Delacroix Unit is attributed to rapid conversion of fresh and intermediate marshes to brackish and saline marshes.

A.5.26. Continued invasion of fresh and intermediate marshes can be expected to result in a decline in harvest of furbearers. Over two-thirds of the state's fur harvest is derived from nutria, which exhibit highest productivity in fresh marsh and the lowest in saline marsh. Furbearers were valued at $16.8 million for their pelts and meat during the 1979-1980 season. A similar situation exists for the alligator population, which also thrives in fresh and intermediate marshes. Expanding saltwater intrusion can be expected to damage a promising revival of the alligator industry that contributed $2 million to the local economy in 1980 (Fruge, 1981).

A.5.27. Fisheries. Marsh loss and saltwater intrusion have had an adverse impact on fishery resources production and seriously threaten the Louisiana fishery resource. In coastal Louisiana, the majority of commercially and recreationally important finfish and shellfish species are estuarine-dependent since juveniles use the estuarine and adjacent wetlands as nursery areas. Louisiana's commercial fishery harvest represents over 25 percent of the total United States harvest every year. In 1980, approximately 1.4 billion pounds valued at $178 million were landed. In addition, estimated are that recreational fishing in Louisiana contributes $150 million annually to the state economy (Aqua-notes, 1981). Historically, Louisiana's most valuable commercial fisheries have revolved around shrimp, menhaden, and oysters. These species, as well as the majority of other finfish and shellfish species of importance in Louisiana, depend heavily on estuarine ecosystems. The EPA (1971) stated that "it is currently assumed that none of the major

commercial species would continue to exist in commercial quantities if estuaries were not available for development."

A.5.28. Average annual harvests have not declined in recent years because of improved technology and increased fishing effort. These factors have compensated for declines in habitat. However, in the opinion of biologists, a continuation of current trends in habitat reduction will be accompanied by a diminishing harvest (Craig et al., 1979). Shrimp and menhaden yields have been directly correlated to the area of wetlands. Turner (1979) reported that the Louisiana commercial inshore catch is directly proportional to the area of intertidal wetlands, and that the area of estuarine open water does not seem to be associated with average shrimp yields. Cavit (1980), in work conducted for the U. S. Fish and Wildlife Service, established that yields of mehanden increase as the ratio of marsh to open water increases. Harris (1973) has stated that total estuarine-dependent commercial fisheries production in coastal Louisiana has peaked and will decline in proportion to the acreage of marshland lost.

A.5.29. Marshes produce large amounts of organic detritus that are transported into adjacent water bodies. Detritus is a very important component of the estuarine food web and is vital to maintaining the high level of fishery productivity in Louisiana. The role and importance of detritus in the estuarine food web is well documented by Darnell (1961) and Odum et al. (1973). Marshes and associated shallow water bodies are used by various life stages of many estuarine-dependent species that take advantage of the protection from predators, warmer temperatures, optimal salinity regimes, and the rich detrital food chain. Many important sport and commercial species depend on shallow marsh areas. They include the Atlantic croaker (Rogers, 1979), menhaden (Simoneaux, 1977), brown and white shrimp (White and Boudreaux, 1977), and blue crab (more, 1969). Conner and Truedale, 1973, demonstrated the value of shallow marsh habitat to juvenile brown and white shrimp, gulf menhaden, Atlantic croaker, sand seatrout, and southern flounder.

A.5.30. Saltwater intrusion has narrowed the broad brackish, low-salinity zones that are vital for the juvenile stage of most important commercial and sport finfish and shellfish. Table A-5-4 shows the optimum and critical salinity ranges for the important fish and shellfish resources. The rising salinities have reduced the low-salinity nursery habitat important to white shrimp and blue crab. Saltwater intrusion is particularly harmful to the American oyster. The optimal salinity range for growth and survival of oysters is 5-15 ppt (Galtsoff, 1964; St. Amant, 1964; and Loosanoff, 1965). Prolonged salinities lower than 5 ppt cause osmoregulatory difficulties in oysters and reduced reproductive capabilities. However, grave problems occur when salinities exceed 15 ppt. Above this level, oysters are subject to considerable predation, parasitism, and disease. The most important enemies of oysters in higher salinities include a carnivorous conch, the southern oyster drill (Thais haemostoma), and the fungus Labyrinthomyxa marina. The black drum, Pogonia cromis, is also a serious oyster predator at certain times. Other notable enemies include boring sponges, polychaete worms, boring clams, and stone crabs. Butler (1953) reported that the southern oyster drill was probably the most destructive single agent affecting the Louisiana oyster industry and the other gulf states. It is generally assumed and reported (Chapman, 1959) that average salinities in excess of 15 ppt favor oyster drill populations. Perret et al. (1971) reported that the majority of drills were caught at salinities above 15 ppt. Burkenroad (1931) reported that salinity seems to be the most important limiting factor for the southern oyster drill. Butler (1953) stated, "The only real barrier to snail (southern oyster drill) migration is a chemical one - lack of sufficient salt in the water. They are normally absent from those areas having a sustained salinity level of less than 15 ppt." The southern oyster drill has plagued the Louisiana oyster industry for years. St. Amant (1938) stated that oyster drills caused estimated losses in oyster production as high as 50 percent statewide. May and Bland (1969) observed that during a 9-month period, over 85 percent of the oysters in a high salinity area were

TABLE A-5-4

KEY ENVIRONMENTAL PARAMETERS AFFECTING IMPORTANT ESTUARINE-DEPENDENT FISHES AND SHELLFISHES*

Species	Spawning Location	Peak Spawning Period	Period of Peak Juvenile Abundance	Optimum Salinity	Critical Salinity and/or Temperature Relationships
American Oyster	On oyster grounds (sessile)	May-September[1] peaks when temperature is 27°C[2]	May-September[1]	5-15 ppt for seed oysters; 10-25 ppt on bedding grounds; above 10 ppt for reproduction[1]	Exposure to salinity less than 5 ppt when temperature greater than 20°C causes mortality[3]. Oysters subject to heavy predation by southern oyster drill at salinities above 15 ppt[4] [15]
Brown Shrimp	Open gulf[3]	March-May[5]	March-May[5]	15-20 ppt best for rapid growth for juveniles[6]	Salinities below 10 ppt and temperatures below 20°C occurring after first week of April lead to decreased growth and survival of post-larvae[6] [7] [9]
White Shrimp	Open gulf[3]	Late spring-early summer; late fall-early winter[5]	Main influx of post-larvae in June-August; smaller influx of over-wintering sub-adults in spring[5]	0.5-10 ppt[8]	Growth of juveniles best at 20-25°C, growth negligible below 15°C[5]
Blue Crab	Copulate in low salinity waters[3]; females migrate to waters greater than 21 ppt to spawn, usually in open gulf or bays[10]	June-August[10]	January-March; June-July[11]	Peak juvenile catches below 5 ppt[3]	Inconclusive.
Menhaden	Gulf[3]	October-March[3]	Summer months[3]	Between 10 and 12 ppt[12]	Optimum catch in 25-35°C waters[12]
Atlantic Croaker	Offshore and deep passes[3]	Fall-winter[3]	Spring-summer[3]	Peak juvenile abundance less than 5 ppt[3]	Inconclusive, greatest juvenile abundance 20-30°C[3]
Spotted Seatrout	Estuaries and lagoons[3]	March-November; peaks when water temperature between 22-25°C and where salinities are 34-36 ppt[3]	Data inconclusive; species in estuary entire year	5-20 ppt[3]	Abrupt decrease in salinity or temperature can cause mass movement to more saline areas[3]
Red Drum	Open ponds and along sand beaches[3]	September-January[13]	Data inconclusive; species in estuary entire year	Data limited; most larvae and juveniles occur at 9-26 ppt; bigger fish prefer higher salinities[16]	Extremes in temperature and salinity tolerated; sudden temperature drops (cold fronts) may cause mortality[14]; greatest catch of juveniles in 5-15°C range

SOURCE: Modified from US Fish and Wildlife Service (1980).

*Numbers in table refer to citations listed below.

1/ Dugas, 1977.
2/ Dugas, 1979
3/ Lindall, et al., 1972
4/ Perret et al., 1971
5/ White and Gaidry, 1973
6/ Barrett and Gillespie, 1973
7/ Ford and St. Amant, 1971
8/ Gunter et al., 1964
9/ St. Amant et al., 1965
10/ Fontenot, 1970
11/ Adkins, 1972
12/ Copeland and Bechtel, 1974
13/ Yokel, 1966
14/ Simmons and Breuer, 1962
15/ Butler, 1953
16/ Benson, 1981

killed by drills. Dugas (1977) reported that oysters remaining in a high salinity areas throughout the summer generally encounter high mortalities from oyster drill predation. Considering this information, the importance of maintaining salinities less than 15 ppt over oyster-producing areas becomes obvious.

NEEDS AND OPPORTUNITIES

A.5.31. The problems of habitat deterioration are of paramount concern to Louisiana and its economy. Marsh loss and conversion of habitats to more saline types has decreased the quality and quantity of fish and wildlife resources. Until some corrective measures are taken, this trend is expected to continue in the future. The most promising measure that could be used to address these problems appears to be large-scale reintroduction of Mississippi River water into estuarine areas. Introducing river water would supply some of the nutrients, sediments, and fresh water that were historically provided to these estuarine systems by natural overbank flooding and distributary flow.

A.5.32. Nutrient-rich Mississippi River water could increase productivity of marsh vegetation, which would help reduce the rate of marsh deterioration. The fact that Mississippi River water has far greater nutrient content than adjacent estuaries has been well documented (Ho and Barrett, 1975). Artifical enrichment of emergent marsh with nutrient-rich wastewater from a menhaden processing plant in coastal Louisiana increased growth of bulltongue, softstem bulrush, and saltmeadow cordgrass by 30 to 51 percent (Payonk, 1975). Fine-grained sediments in the river water would also be transported to marsh areas. Delaune et al. (1978) reported that the entrapment and stabilization of suspended inorganic sediment by marsh vegetation is an important process that helps offset effects of subsidence. Delaune also noted that incoming sediment supplies nutrients for plants that subsequently enhance further entrapment and stabilization of sediments. Increased

plant productivity associated with increased nutrients also contributes to a stronger peat base. Thus, maintenance of a healthy marsh is accomplished by the aggradational processes of plant growth, accumulation of detritus, and deposition of inorganic sediments. Baumann and Adams (1981) reported a reduced rate of marsh loss in those areas under the influence of Atchafalaya River inflows as compared to areas receiving little or no freshwater influence. In addition to the impacts of increased nutrients and sediments on marsh productivity, reducing salinity would retard the rate of saltwater intrusion into fresh marsh areas and reduce the loss of these wetlands.

A.5.33. Reducing salinities would help to restore low-salinity areas where these zones have been eliminated or greatly reduced by saltwater intrusion. Restoring these areas would benefit species requiring such areas as nursery habitat. Samples taken throughout the Louisiana coastal zones have shown the greatest catch of juvenile white shrimp, blue crabs, menhaden, and other finfishes in lower salinity waters. Reducing salinities would prove invaluable in improving and restoring oyster-producing areas, especially areas where encroaching salinities have allowed the southern oyster drill and other predators and disease organisms to move in over the oyster reefs. As previously discussed, the southern oyster drill cannot survive prolonged exposure to salinities less than 15 ppt and reducing salinities is an important control measure. Control of the oyster drill is the primary reason the State of Louisiana constructed diversion structures at White's Ditch and Bayou Lamoque in Plaquemines Parish. Controlling the oyster drill was an important justification for four unconstructed Federally-authorized diversion structures in Plaquemines Parish.

A.5.34. Recent studies have documented the value of increased freshwater diversions to oyster production in southeastern Louisiana. According to Pollard (1973), the commercial harvest of oysters from public grounds within Breton Sound in 1970 was 580,000 pounds. However,

ugas (1977) reported commercial (sack) production from the same area as eing 1,508,277 pounds for the 1974-75 season and 4,158,275 pounds for he 1975-76 season. This high rate of production, according to Dugas, as considered to be a direct result of increased freshwater runoff eceived during 1973, 1974, and 1975. The increased runoff entered the rea through the freshwater diversion structure at Bayou Lamoque and hrough breaks in a deteriorated levee along the east bank of the ississippi River betwen the diversion structure and Baptiste Collette ayou. The difference between the 1970 harvest and the 1974-1975 and 975-1976 harvest is approximately 2,253,276 pounds.

.5.35. Diversion of nutrient-rich Mississippi River water would serve o increase the growth of marsh vegetation and help slow the rate of and loss. Increased plant growth should also result in greater produc-ion of organic detritus responsible for a high rate of fisheries pro-uctivity. The increased nutrient inflow should also increase the roduction of phytoplankton and zooplankton and lead to greater harvest f sport and commercial fishes and shellfishes directly or indirectly ependent on these microscopic organisms.

.5.36. Although some oyster mortalities have occurred during previous penings of the Bonnet Carre Spillway, the overall effects of such ction on fisheries have been generally beneficial. The beneficial ffects have been observed for several years following each opening. iosca (1938), reporting on the effects of the 1937 opening of the onnet Carre Spillway, noted that the opening had significant beneficial ffects on oysters, saltwater finfishes, river shrimp, crawfish, and enaeid shrimp in Lake Pontchartrain, Lake Borgne, and Mississippi ound.

.5.37. A late opening (April 24 to May 17) of the spillway in 1945 aused extensive oyster mortalities in Mississippi Sound, but benefited ysters farther removed from the primary impact area, according to

Gunter (1950). Gunter also reported on the 1950 opening of the spillway stating, "Since oyster mortality was slight and nutrients were brought into the area by the river water and certain predators and injurious organisms were exterminated in the area, it is clear that the 1950 opening . . . was beneficial to the oyster beds in Mississippi Sound and the Louisiana marsh."

A.5.38. Freshwater introduction is expected to have beneficial effects on menhaden production. Menhaden are an important industrial fish because of their high oil content. The fish meal that remains after the oil is extracted is a valuable livestock feed supplement. The Gulf of Mexico and associated marshes and estuaries are the most important menhaden-producing areas in the world. Over one-half of the menhaden landings in the United States come from the gulf. During flood years when large volumes of nutrient-rich fresh water from the Mississippi River enters the gulf and associated estuaries, the fertility of these water bodies is increased. Menhaden feed on plankton and other nutrients, and plankton abundance depends on water fertility. Following the release of large volumes of fresh water through the Bonnet Carre' Spillway in 1973, the menhaden catch in the Mississippi Sound area was higher than in previous years, but more important, the oil yield was up 54 percent over the average for the previous 15 years (Wallace, 1978). Water fertility resulting in increased plankton production is recognized as important to a healthy menhaden population.

A.5.39. This discussion does not describe the entire range of benefits attributable to freshwater diversion. There are a variety of unquantifiable benefits that warrant consideration when analyzing the merits of freshwater diversion. Gosselink et al. (1979) reported that an acre of gulf coast marsh has an annual value of $4,000 for waste processing and life support benefits. Another unquantified benefit is related to the fact that reduction in marsh loss and increased productivity of the vegetation in Louisiana's marshes could also result in benefits to the

heries in Mississippi Sound. It is widely believed that many of the
cies harvested from the Mississippi Sound use the Louisiana wetlands
nursery areas.

.40. Another unquantified aspect of freshwater diversion is pre-
ving and rejuvenating existing cypress-tupelo swamps in the upper
ins. Introducing supplemental fresh water into these areas would
sh anoxic waters and arrest or retard saltwater intrusion responsible
mortality of cypress and tupelogum trees. In the Jean Lafitte
ional Park, recently established near Lafitte, Louisiana, several
usand acres of cypress-tupelo swamp and fresh-to-intermediate marsh
subject to saltwater intrusion. Introducing freshwater in the upper
of the Barataria Basin would help arrest the saltwater intrusion
blem and preserve the esthetic beauty and biological productivity of
national park.

.41. A monetary benefit that could be associated with freshwater
ersion is preservation of the wetland habitat that so many species of
game, noncommercial fish, and wildlife depend on in coastal
isiana. These benefits were not quantified in this report. The
lands are of great importance to the well-being of such migratory
ds as shorebirds, gulls, terns, raptors, and songbirds and provide
ortant habitat to other nongame wildlife such as reptiles, amphibi-
, and small mammals. Freshwater introduction would help sustain the
ersity and quality of those habitats important in maintaining the
ulations of living resources.

.42. As the previous discussion indicates, annual introduction of
trolled amounts of freshwater at an appropriate time of the year is
essary to restore, improve, and manage the fish and wildlife
ources in areas. An interagency ad hoc group has identified the
sonal salinity gradients believed necessary to maximize resource
ductivity and the supplemental freshwater required to maintain these

gradients (U. S. Army Corps of Engineers, 1970). After detailed study, the ad hoc group reached general agreement on salinity conditions and water levels necessary to maintain and enhance the estuarine water bodies and the marshes. These two habitats have different requirements.

A.5.43. The first requirement is to maintain a certain salinity gradient in the estuarine water bodies during specific months of the year. The desirable condition is defined by the position of the 15 ppt mean salinity isohaline constructed across the coastal zone (plate A-9). During spring, summer, and fall, an average salinity of 15 ppt should be maintained at the line shown. Short duration fluctuations due to wind and tide are tolerable. This regimen is required to maximize productivity in the commercial and sport fishery resources. The aquatic habitat regimen will need the largest quantity of supplemental water. The location of the recommended isohaline represents desirable conditions and is not based on historically documented salinity conditions. The ad hoc group noted that this location would increase the nursery areas used by marine fisheries and restore oyster reefs no longer suitable for oysters to their former high productivity.

A.5.44. The second requirement pertains primarily to marsh salinities. The line demarking the brackish-saline marsh contact has been designated as a critical line for defining salinity requirements of the marsh communities. The fresh-to-brackish marshes are the preferred habitat of the important commercial and sport wildlife species. Wildlife productivity is directly correlated with plant growth and composition (Palmisano, 1973). The vitality of the plant communities depends on freshwater and nutrient inputs. Reducing overflow and nutrients has reduced the area of preferred wildlife habitat. Comparing marsh vegetation in the period 1941-1945 and 1968 indicates that the brackish-saline marsh interface has shifted significantly in a number of areas during the 25-year period. Most shifts indicate saltwater encroachment and have been deemed detrimental. A seaward shift of the interface is

considered favorable. It would be desirable to re-establish the 1941-1945 position of the line in those instances where saltwater encroachment has occurred. In order to achieve these results, it has been recommended that the seawardmost position of the saline-brackish marsh contact (a combined line constructed from 1945 to 1968 marsh-vegetation maps as shown on plate A-9) be used to define desirable salinity conditions from the standpoint of marsh ecology. To achieve the conditions, the salinities must not exceed 15 ppt salinity at this line more than 5 percent of the time. If the condition established for the estuarine water bodies is met, the condition recommended for the brackish-saline marsh contact will also be met in spring, summer, and fall. This requirement establishes the index for water needs during the fall and winter. The recommended isohalines are shown in plate A-9.

A.5.45. The recommended isohalines were used to develop estimates of supplemental water requirements. The isohalines were compared with the salinity data at key measuring stations and the water yield in the area (Gagliano et al., 1973). A water yield less than required to maintain the desired salinity gradient indicates that a deficit exists. Analysis of the deficits yielded estimates of the supplemental water required. The supplemental freshwater requirements determined in the early study were reevaluated and are presented in Section 1 of the Appendix C, Engineering Investigations.

A.5.46. In summary, opportunities exist to improve the fish and wildlife resource by improving management practices, establishing sanctuaries, filling open water areas with dredged material to create new marsh, regulating the alteration of wetlands, placing barriers to reduce saltwater intrusion, and introducing freshwater.

AD-A152 704 LOUISIANA COASTAL AREA LOUISIANA FRESHWATER DIVERSION TO BARATARIA AND BR..(U) ARMY ENGINEER DISTRICT NEW ORLEANS LA D L CHEW SEP 84 2/7

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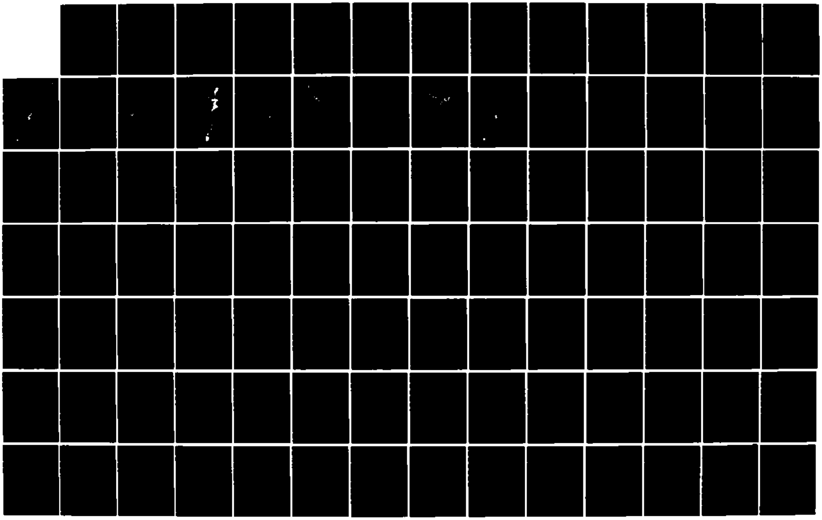

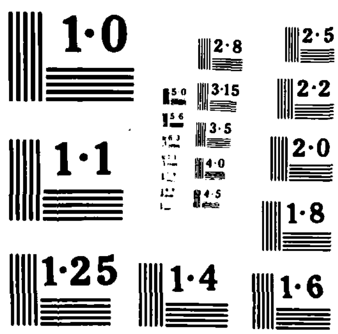
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RECREATIONAL RESOURCES

A.5.47. The opportunities for sport fishing and hunting in the area are related to the availability of the fish and wildlife resources and access to these resources. The quality and quantity of the sport fish and wildlife resources depends on the changes in habitat conditions. Deterioration in habitat conditions reduces productivity of important game species, thereby reducing the sportsman's success. Projected adverse habitat changes could reduce potential opportunities for freshwater finfishing by 78 percent, crawfishing by 65 percent, saltwater finfishing and shellfishing by 43 percent, and sport hunting by 45 percent by the year 2035. Table A-5-5 depicts the projected changes in important fish and wildlife habitats. The potential opportunities for sport fishing and hunting are further constrained by the lack of access. The need for boat launching ramps is expected to increase from 1,050 lanes in 1985 to 1,587 lines by 2035. Thus, there is a need for improving opportunities for recreation. Opportunities exist for improving the resource base by improving fish and wildlife management practices, establishing sanctuaries, regulating the alteration of wetlands, controlling saltwater intrusion, and introducing freshwater to improve habitat conditions.

CULTURAL RESOURCES

A.5.48. The cultural resources are located along abandoned natural levees of the Mississippi River and numerous bayous in the area. Many of the archeological sites are being adversely affected by subsidence and erosion. Opportunities exist to reduce these adverse affects by introducing freshwater to the marshes and regulating land use conversion.

A-5-5

PROJECTED PERCENT CHANGE IN IMPORTANT
FISH AND WILDLIFE HABITAT 1/

Activity	1978	1985	1995	2005	2015	2025	2035
Freshwater Finfishing 2/	100	83	64	49	38	29	22
Crawfishing 3/	100	87	72	60	49	42	35
Saltwater Finfishing and Shellfishing 4/	100	93	84	76	70	63	57
Sport Hunting 5/	100	89	84	75	68	61	55

SOURCE: Modified after US Fish and Wildlife Service (1980).

1/ The decline in the sport harvest parallels the projected losses in important habitat types.
2/ Includes fresh and intermediate marsh types.
3/ Includes wooded swamp and fresh and intermediate marsh types.
4/ Includes bottomland hardwood, wooded swamp, and fresh, intermediate, and brackish marsh types.

Section 6. PLANNING CONSTRAINTS

PROBLEM ANALYSIS

A.6.1. In the estuarine-marsh complex, there is a synergistic relationship between freshwater, sediment, nutrients, levels of salinity, and resource productivity. To analyze the advisability of preventing saltwater intrusion into the area requires that these environmental parameters be addressed as a whole, not individually. However, associating reduction and changes in the salinity gradients with increase in primary productivity of habitat types and fish and wildlife populations is a complex problem. Actual experience with diversions for the purpose of conserving and enhancing fish and wildlife resources is limited in scope and duration. The current knowledge of relationships between changes in physical and chemical parameters and biological communities is derived in part from small scale fish and wildlife diversions and diversions for flood control, but is based largely on inductive reasoning and expert judgement. There is no one accepted method for relating primary productivity to the harvest of fish and wildlife and the benefits to be derived from reducing salinities. Studies to refine current information would require several years of basic research, extensive data collection, and development of hydrologic and water quality models. The effort could take four years or more to accomplish. In view of these constraints, the most reasonable approach was to limit the study effort to review and evaluation of existing information and available data.

SCALE OF DEVELOPMENT

A.6.2. The magnitude and the duration of the supplemental water required to establish the desired salinity gradients were determined by extensive hydrologic and hydraulic analyses as discussed in Section 1, Appendix C, Engineering Investigations. The scale of development being

considered is to divert supplemental water January through April to maintain the average position of the mean 15 ppt isohaline for fisheries shown in plate A-9 from April through September in the 10-percent drought years when salinity will be high. During droughts that occur more frequently than the 10-percent drought, smaller quantities of water sufficient to offset the drought could be discharged.

A.6.3. Water temperature is also a constraint. The Mississippi River, the source of supplemental water, is generally cooler than the receiving waters during January through July. Juvenile fish are sensitive to water temperatures that affect migration and growth rates. Since large numbers of juveniles arrive in the estuaries during April, a major constraint is to avoid thermal shock to immigrating juveniles by stopping or severely limiting the quantity of diverted water after April.

Section 7. PLANNING OBJECTIVES

A.7.1. Planning objectives that will enhance the national economic development (NED) and environmental quality objectives are determined by the specific national, state, and local water and related land resource management needs in the study area. NED is achieved by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.

A.7.2. The following objectives have been developed based on identified problems, needs, and opportunities and the concerns of the public and Federal, state, and local interests.

- o Restore and maintain favorable salinity regimes in wetlands and estuaries to increase fish and wildlife productivity.

- o Increase commercial fisheries production to meet the demands for fish products, and stabilize the wide fluctuations in the fisheries industry.

- o Increase commercial wildlife production to meet the demands for pelts and hides, and stabilize the wide fluctuations in the wildlife industry.

- o Improve sport fishing opportunities to satisfy a portion of the sport fishing demands and to increase the quality of the fishing experience by not lowering the "expected catch."

- o Improve sport hunting opportunities to satisfy a portion of the sport hunting needs.

- Enhance growth of marsh and aquatic vegetation to reduce land loss and increase the nutrient supply for fish and wildlife productivity.

- Preserve, restore, and create natural habitats to offset potential declines in fish and wildlife populations and reduce erosion, subsidence, and avenues for saltwater intrusion.

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LOUISIANA COASTAL AREA STUDY

INTERIM REPORT ON FRESHWATER DIVERSION

TO

BARATARIA AND BRETON SOUND BASINS

Appendix B

FORMULATION, ASSESSMENT, AND EVALUATION OF DETAILED PLANS

B.0.1. In this appendix, the process of formulating alternative plans and the rationale for selecting a tentatively selected plan is described. In Section 1, management measures are evaluated and the most feasible measures are incorporated into an array of specific plans. The plans are assessed and evaluated in terms of engineering feasibility and adverse and beneficial effects in Section 2. The plans are compared and the rationale for the tentatively selected plan is presented in Section 3.

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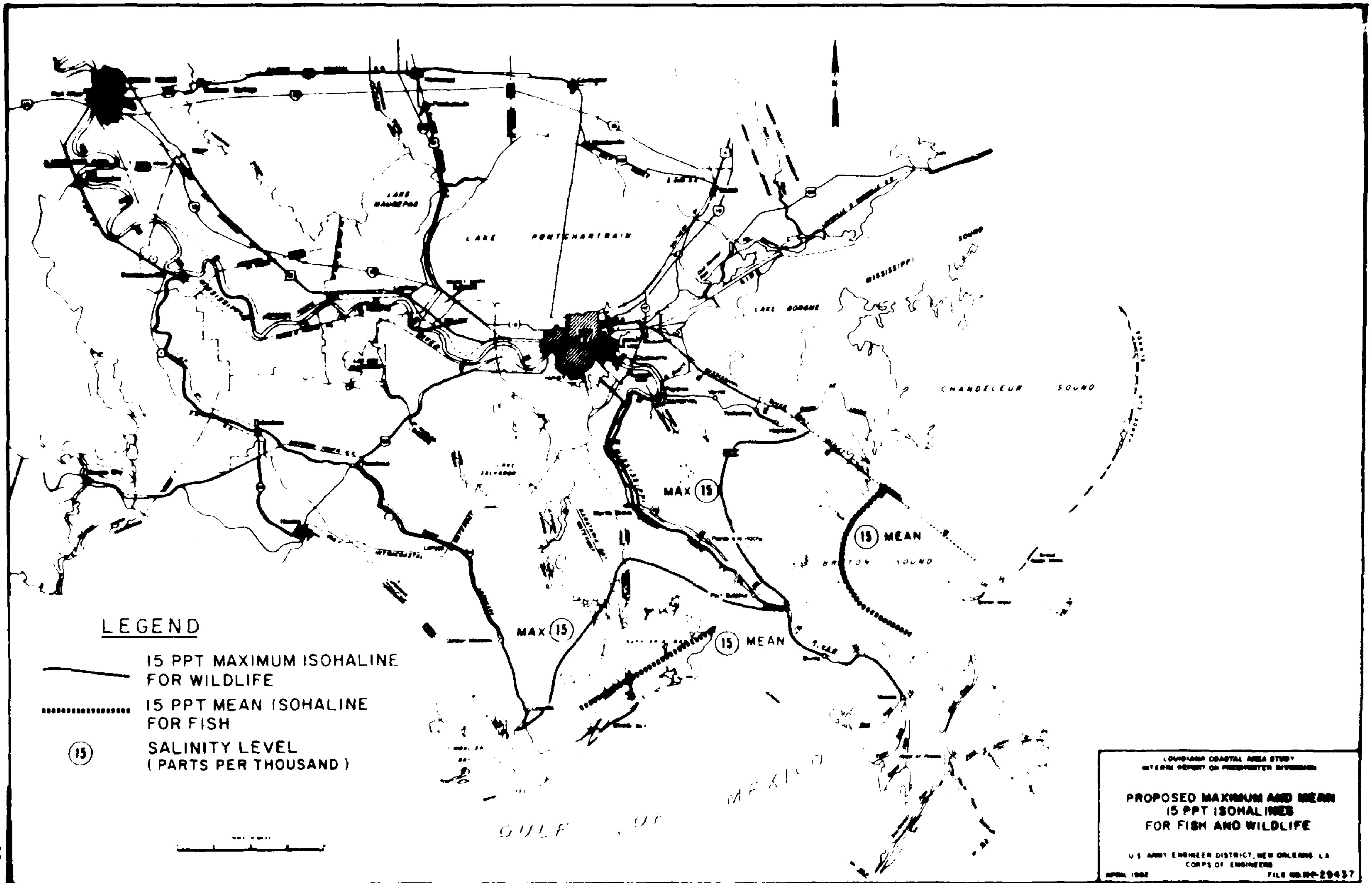
APPENDIX B

FORMULATION, ASSESSMENT, AND EVALUATION OF DETAILED PLANS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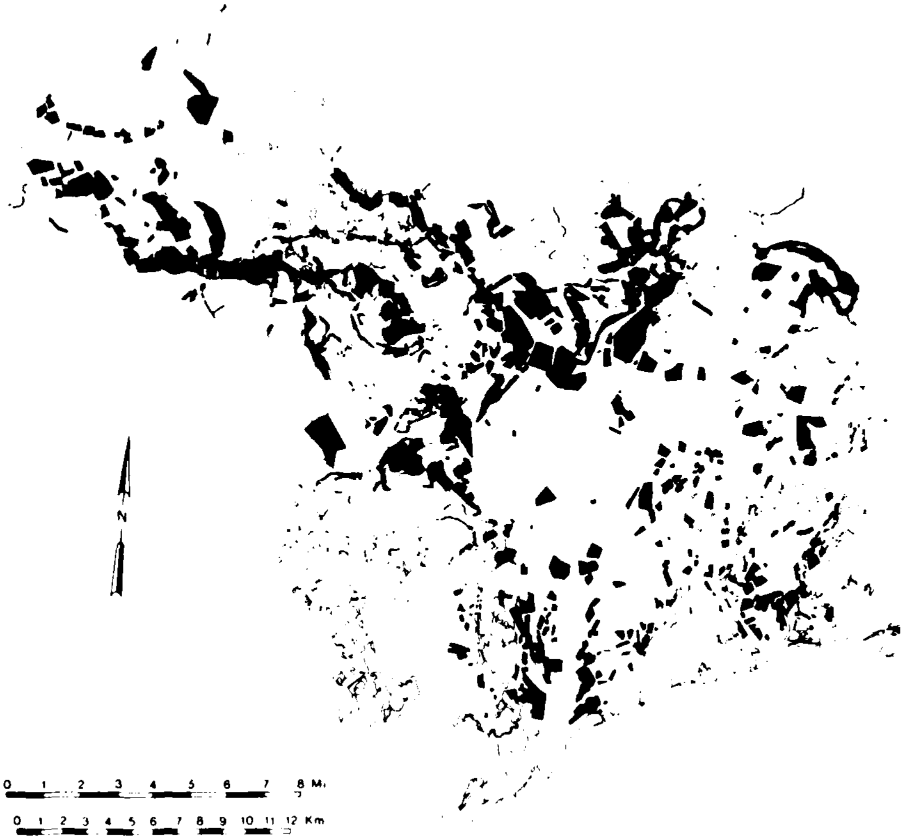
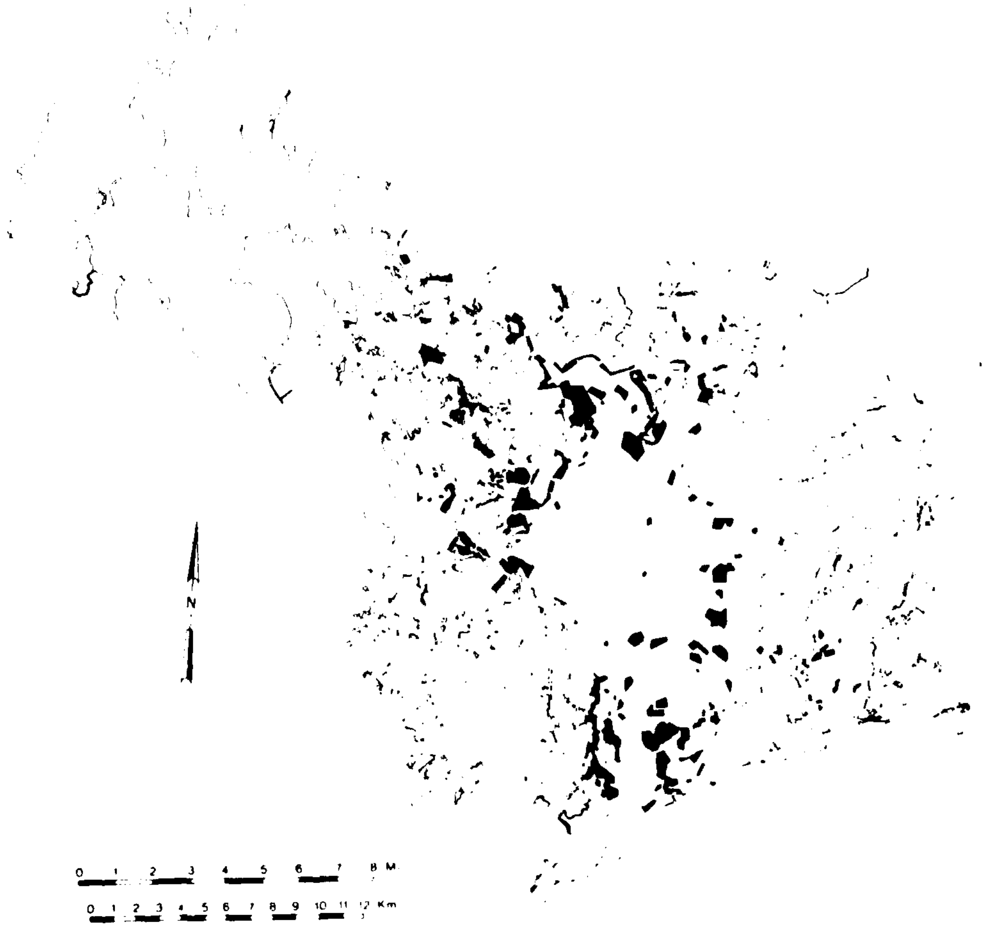
LAKE PONTCHARTRAIN
LAKE BORGNE
MISSISSIPPI SOUND
CHANDELEUR SOUND
BRETON SOUND
LAKE SALVADOR
GULF OF MEXICO
MAX 15
15 MEAN
LEGEND
15 PPT MAXIMUM ISOHALINE FOR WILDLIFE
15 PPT MEAN ISOHALINE FOR FISH
15 SALINITY LEVEL (PARTS PER THOUSAND)
PROPOSED MAXIMUM AND MEAN 15 PPT ISOHALINES FOR FISH AND WILDLIFE
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA
CORPS OF ENGINEERS
PLATE A-9

PLATE A-9



Area leased for oyster culture in the Barataria Bay area in 1975.
(after Van Sickle, et al., 1976)



Area leased for oyster culture in the Barataria Bay area in 1959
(after Van Sickle, et al., 1976)

PLATE A-6.

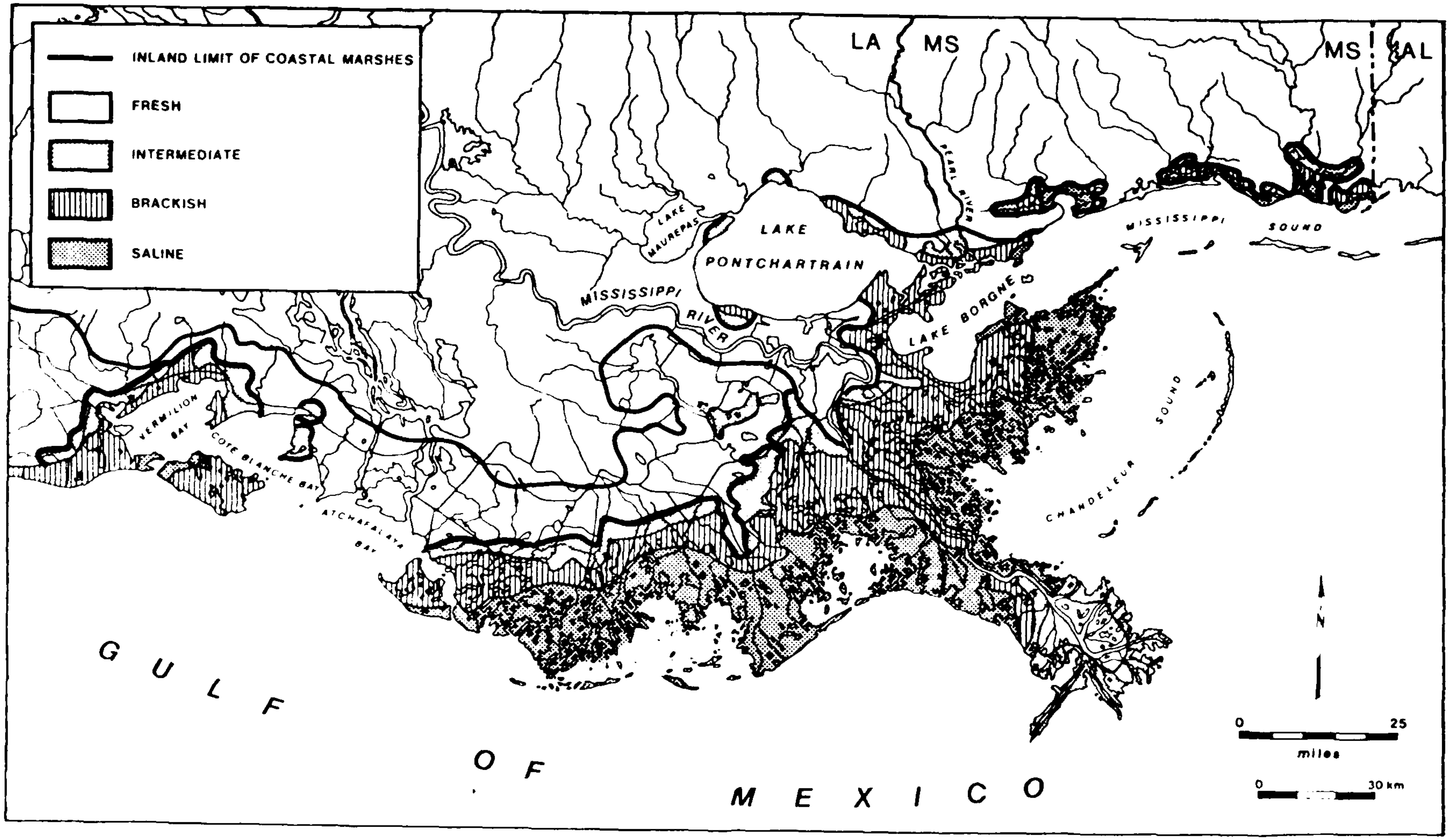


PLATE A-6. Approximate boundaries of fresh, intermediate, brackish, and saline marsh types in the the Mississippi Deltaic Plain Region in 1978. The marsh types on the barrier islands and the fresh marshes in Mississippi are not shown because of their small area (Chabreck and Linscombe 1978, Eleuterius 1973).

PLATE A-5.

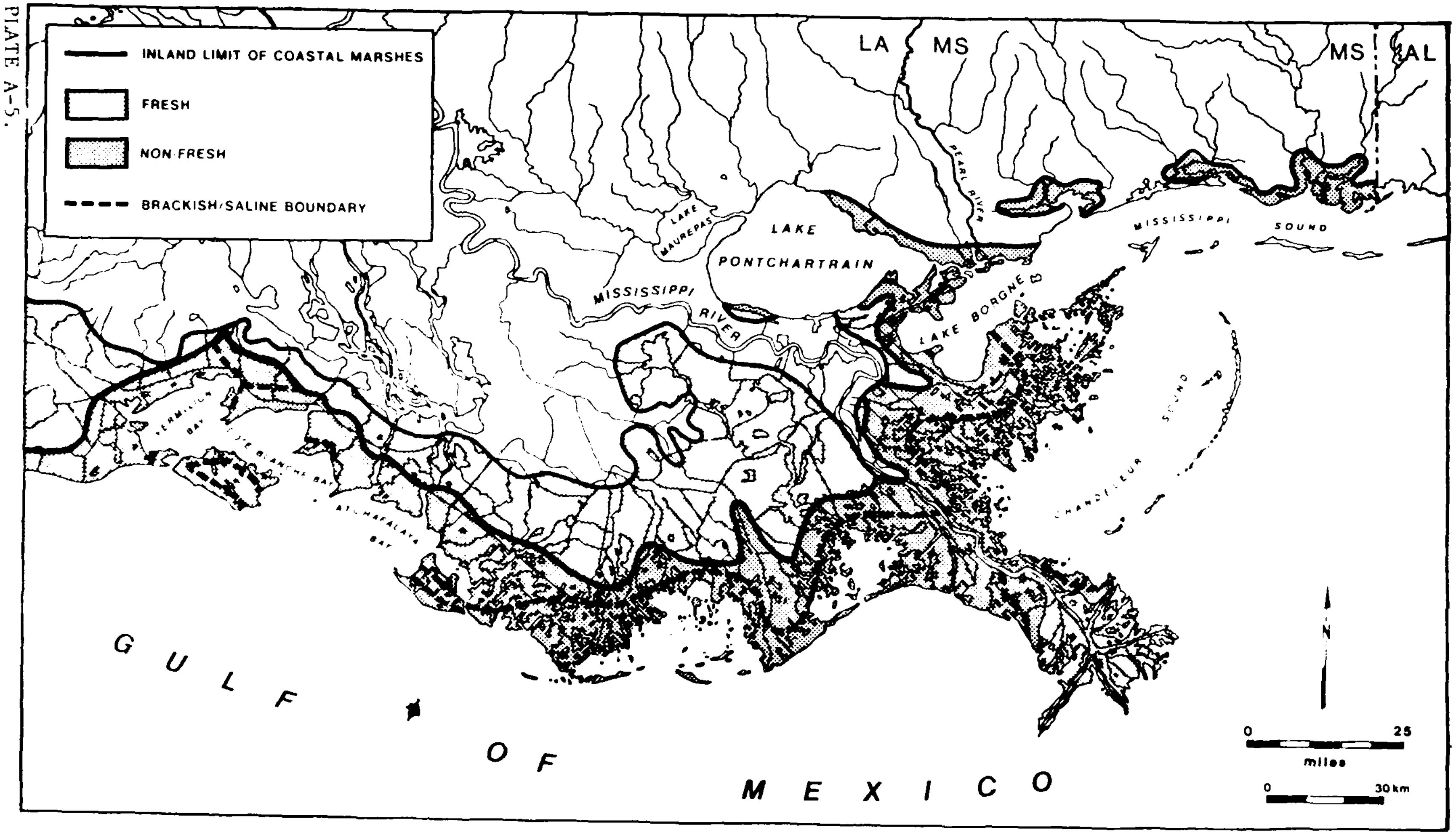
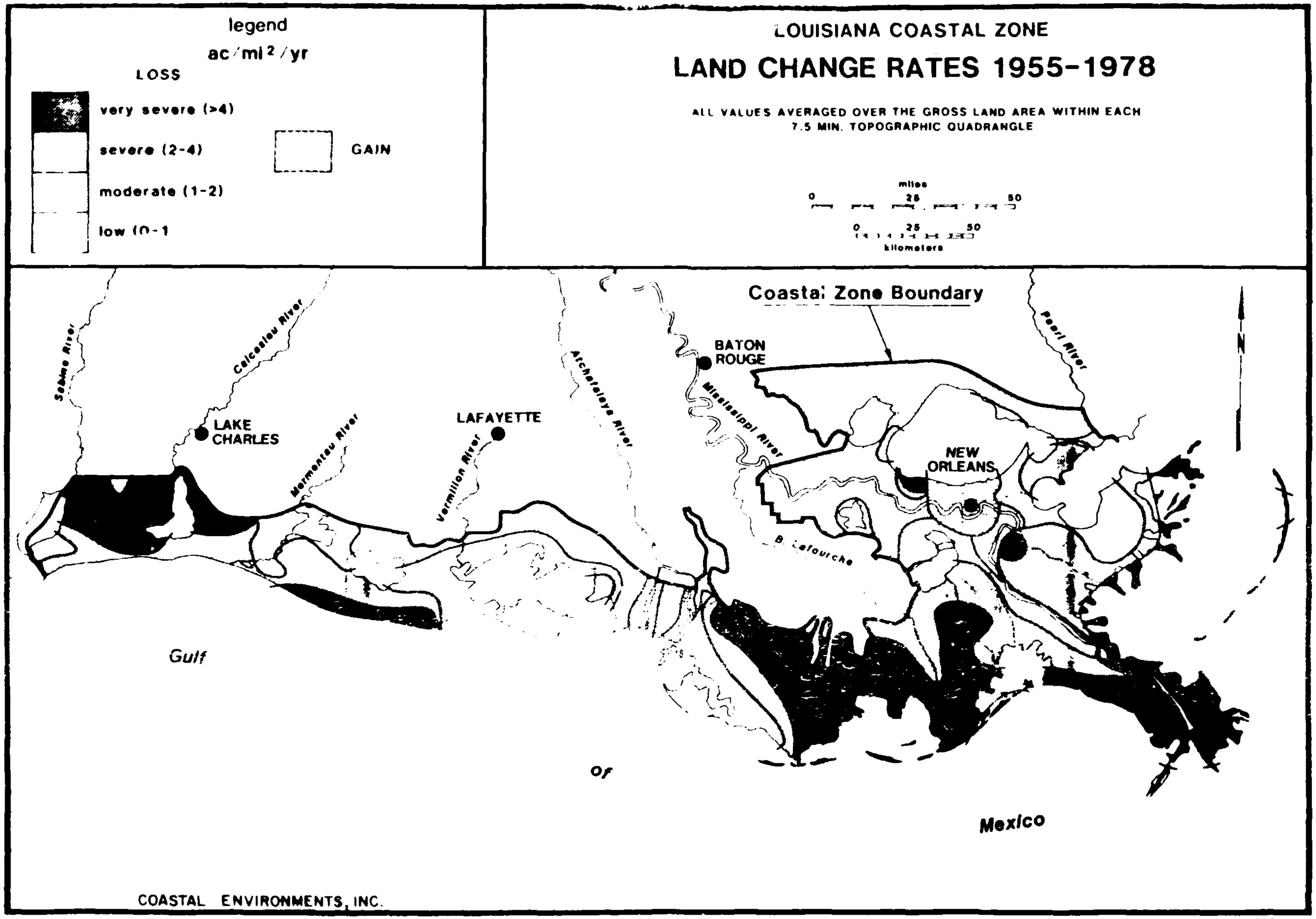


PLATE A-5. Approximate boundaries of fresh and non-fresh marshes in the Mississippi Deltaic Plain Region in the 1950s. The marsh types on the barrier islands and the fresh marshes in Mississippi are not shown because of their small area (O'Neil 1949; Eleuterius 1973; USDI, FWS 1955a, 1955b).



legend
ac/mi² /yr
LOSS
very severe (>4)
severe (2-4)
moderate (1-2)
low (0-1
GAIN
LOUISIANA COASTAL ZONE
LAND CHANGE RATES 1955-1978
ALL VALUES AVERAGED OVER THE GROSS LAND AREA WITHIN EACH 7.5 MIN. TOPOGRAPHIC QUADRANGLE
miles
0 25 50
0 25 50
kilometers
Coastal Zone Boundary
N
Sabine River
Calcasieu River
LAKE CHARLES
Mermentau River
Vermilion River
LAFAYETTE
Atchafalaya River
BATON ROUGE
Mississippi River
B. Lafourche
NEW ORLEANS
Pearl River
Gulf
of
Mexico
COASTAL ENVIRONMENTS, INC.

PLATE A-4

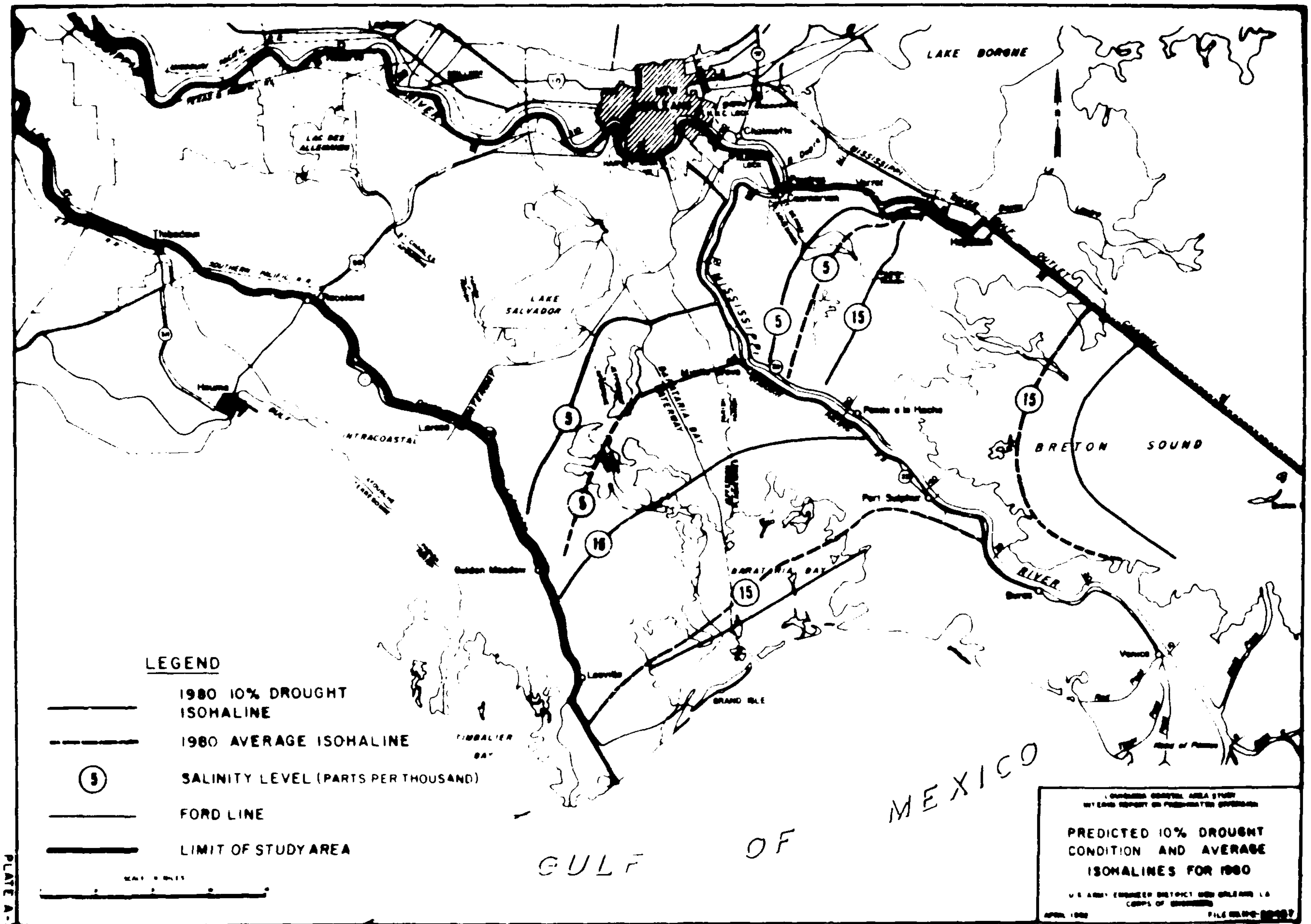

LAKE BORGNE
LAKE SALVADOR
BRETON SOUND
MISSISSIPPI
RIVER
BARATARIA BAY
INTRACOASTAL
TIMBALIER BAY
GRAND ISLE
Port Sulphur
Pointe a la Hache
Venice
Golden Meadow
Leeville
Thibodaux
Raceland
Houma
Lockport
Chalmette
GULF OF MEXICO
5
15
LEGEND
1980 10% DROUGHT ISOHALINE
1980 AVERAGE ISOHALINE
SALINITY LEVEL (PARTS PER THOUSAND)
FORD LINE
LIMIT OF STUDY AREA
PREDICTED 10% DROUGHT CONDITION AND AVERAGE ISOHALINES FOR 1980
PLATE A-3

PLATE A-3

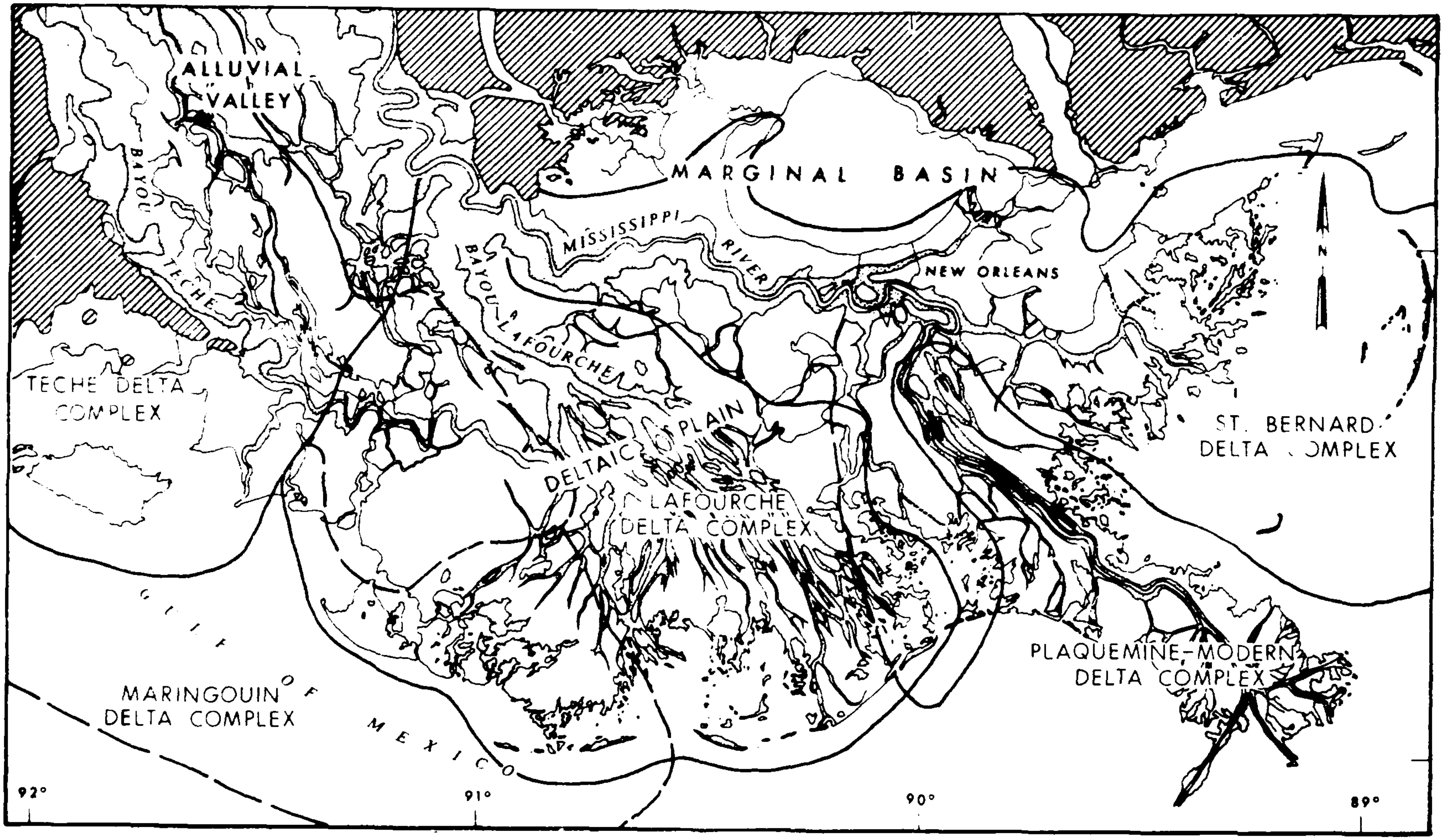
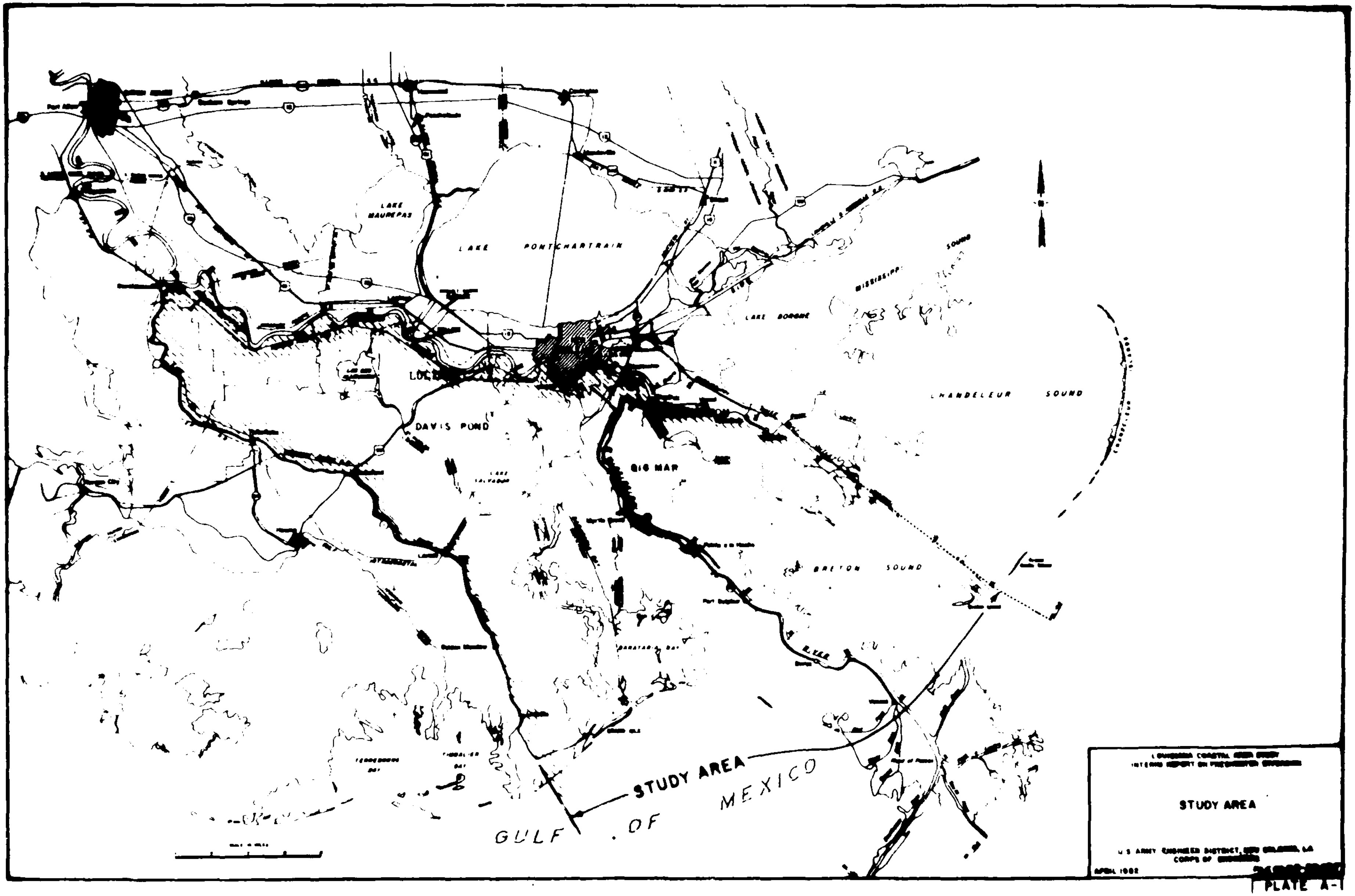


PLATE A-2

Principle delta lobe complexes (after Gagliano et al, 1971).

PLATE A-2


LAKE MAUREPAS
LAKE PONTCHARTRAIN
LAKE BORGNE
MISSISSIPPI SOUND
CHANDELEUR SOUND
DAVIS POND
BIG MAR
BRETON SOUND
STUDY AREA
GULF OF MEXICO
STUDY AREA
PLATE A-1

Section 1. FORMULATION OF ALTERNATIVE PLANS

MANAGEMENT MEASURES

B.1.1. In the preliminary stage of plan formulation, a broad range of measures was identified that could address one or more of the planning objectives presented in Appendix A. The measures were: divert freshwater, construct saltwater barriers, fill open water areas, regulate alteration of wetlands, establish sanctuaries, and manage fish and wildlife. Table B-1-1 shows the planning objectives that each measure would meet.

B.1.2. Freshwater diversion. The former Mississippi River overflow regime could be simulated by diverting river water with its sediment and nutrients into the adjacent marshes and estuaries. The diversion could be accomplished by placing gravity flow control structures in the Mississippi River levee and by dredging a training channel to the receiving water body. Other methods would be the use of siphons or pumping stations that would lift the required flow over the Mississippi River mainline flood control levee. The structure or pumping station would be operated as stages in the river and tailwater areas permit according to the need for supplemental freshwater to enhance habitat conditions of fish and wildlife species using the area.

B.1.3. Saltwater barriers. Saltwater intrusion could be retarded by placing navigable barriers in major canals. The barriers would remain open to permit fish migrations, but would be closed during periods of low freshwater inflows and high tides in the gulf. Saltwater inflows could be further reduced using weirs and artificial barrier islands. A combination of artificial barrier islands, weirs, and saltwater barriers would reduce the amount of freshwater required to alter the existing salinity gradients and would help retain freshwater in the marshes. The barriers would be designed to pass the flood of record.

TABLE B-1-1

MANAGEMENT MEASURES AND PLANNING OBJECTIVES

Measure	Planning Objectives* PRW	EVG	FSG	ICF	ICW	ISF	ISW
Freshwater Diversion	MD+	Mj+	Mj+	Mj+	Mj+	Mj+	Mj+
Saltwater Barriers	Md+	Mn+	Md+	Mn+	Md+	Mn+	Md+
Regulate Alteration of Wetlands	Md+	0	Mn+	Md+	Md+	Md+	Md+
Fill Open Water Areas	Mn+	Mn+	Mn+	Mn+	Mn+	Mn+	Mn+
Establish Sanctuaries	Mn+	0	0	Mn+	Mn+	Mn+	Mn+
Manage Fish and Wildlife	0	Mn+	0	Mn+	Mn+	Mn+	Mn+

* Planning Objectives: PRW = Preserve and Restore Wetlands; EVG = Enhance Vegetative Growth; FSG = Favorable Salinity Gradients; ICF = Increase Commercial Fisheries Production; ICW = Increase Commercial Wildlife Production; ISF = Improve Sport Fishing Opportunities; ISW = Improve Sport Wildlife Opportunities. Type of Contribution: Mj = Major; Md = Moderate; Mn = Minor; 0 = No effect.

B.1.4. Fill open water areas. Dredged material obtained during maintenance dredging of navigation projects in the area could be used to fill subsiding areas.

B.1.5. Regulate alteration of wetlands. Regulating activities that alter the wetlands would aid in preserving and maintaining the area for fish and wildlife.

B.1.6. Establish sanctuaries. Critical and unique fish and wildlife breeding, nursery, and feeding grounds could be preserved by establishing sanctuaries.

B.1.7. Manage fish and wildlife. Fish and wildlife productivity could be improved by such management practices as regulating harvests, stocking programs, planting cultch material for oysters, planting vegetation, and controlled marsh burning. Harvest regulations could include controlling seasons to protect various fish and wildlife species during critical stages in their life cycles, creel and bag limits to prevent overharvest of fish and wildlife species, size limits to prevent taking certain species before sexual maturity, restrictions on taking females, and restrictions on harvesting gear to prevent overharvest of certain fish and wildlife species. Stocking programs can be effectively used to increase populations of certain fish and wildlife species. In recent years, red drum have been stocked in Texas waters and it appears that stocking efforts have been beneficial. Certain species of game birds can also be stocked. Planting cultch material to provide a firm substrate for attachment of oyster larvae (spat) following their free-swimming stage has been done for many years and has proved very successful.

B.1.8. Constructing artificial reefs or structures is beneficial for many species of commercially and recreationally important fish. Restoring cheniers would provide habitat for many wildlife species.

This habitat type is very valuable and is rapidly disappearing as a result of residential construction and industrial uses of the area.

B.1.9. Planting and propagating certain species of vegetation provides food and habitat for fish and wildlife species and serves to reduce land loss. Controlled burning of marshes during mid- to late winter serves to remove dead residual marsh vegetation and release nutrients that stimulate vegetative growth the following spring and summer. Increased production of vegetation provides food and cover for waterfowl and furbearers and provides a source of detritus important to fishery resources.

PLAN FORMULATION RATIONALE

B.1.10. The management measures include suggestions made by participants at public meetings and coordination meetings with representatives of interested Federal, state, and local agencies. With the numerous specific possibilities for accomplishing each measure and the combinations between measures, the potential alternative plans are innumerable. Therefore, an intervening step was taken before identifying alternative plans. The step consisted of analyzing and screening each measure and developing specific possibilities for the measures to be included in the plans.

B.1.11. Available information, generalized analyses developed from available information, and the judgement of individuals where information was incomplete or too costly and time-consuming to develop were used to analyze and screen measures. Benefit-cost ratios were not used. Comparisons used included least costly, most feasible from an engineering viewpoint, fewest adverse construction impacts, most beneficial impacts, and more complete meeting of objectives. The specific possibilities identified for retained measures were used to formulate specific alternative plans.

B.1.12. The plans were evaluated and compared and the plan that maximized contributions to national economic development was identified and presented to the public as the tentatively selected plan. The plan was discussed at a public meeting held in New Orleans on June 1, 1982. In general, public officials and residents indicated support for the concept of freshwater diversion, but opposed the Barataria element of the plan. In subsequent coordination meetings with representatives of state and local agencies, an alternative plan responsive to local concerns was identified.

ANALYSIS AND SCREENING OF MEASURES

FRESHWATER DIVERSION

B.1.13. As previously stated, diversion can be accomplished by gravity flow control structures, siphons, or pumping. Considering the large quantity of flow needed, 6,600 cubic feet per second (cfs) in Breton Sound and 10,650 cfs in the Barataria Basin, siphons would be impractical because of size and head loss. Based on past experience with pumping versus gravity flow structures, the cost of construction, operation, and maintenance of pumping stations make such measures the least economical. For this reason, pumps were eliminated from further consideration.

B.1.14. Initially, 20 sites were identified for possible diversions. During a reiteration of plan formulation, the number of potential sites was expanded to include a site at Davis Pond. The Davis Pond site was added when substantial opposition to some of the initial 20 sites arose. As a result of coordination with the State of Louisiana Governor's Coastal Protection Task Force, the Davis Pond site was selected. A site at this location had been considered in early studies, but it did not meet the planning criteria as well as other sites. The potential sites are shown in table B-1-2. The sites are at locations where

TABLE B-1-2

POTENTIAL FRESHWATER DIVERSION SITES

Basin	Site Name	Receiving Water Body
Breton Sound	Caernarvon Canal	Lake Lery
	Near Caernarvon	Big Mar
	Bohemia	American Bay
Barataria	Bayou Becnel	Lac Des Allemands
	Johnson	Lac Des Allemands
	Bayou Lasseigne	Lac Des Allemands
	Bayou Fortier	Lac Des Allemands
	Davis Pond	Lake Cataouatche
	Lenoux Canal	Lake Cataouatche
	Sellers Canal	Lake Cataouatche
	Saul's Canal	Lake Cataouatche
	Willswood Canal	Lake Cataouatche
	Waggaman Canal	Lake Cataouatche
	Avondale Canal	Lake Cataouatche
	Bayou Segnette	Lake Cataouatche
	Harvey Lock	Bayou Barataria
	Algiers Lock	Bayou Barataria
	Hero Canal	Bayou Barataria
	Oakville	Bayou Barataria
	Myrtle Grove	Wilkinson Canal
	Homeplace	Adams Bay

connections to the river currently exist or previously existed, or where development between the river and the receiving water body is sparse.

B.1.15. The four sites identified in the authorized Mississippi Delta Region project of the Flood Control, Mississippi River and Tributaries project are included as potential sites. The Mississippi Delta Region project consists of four salinity control structures with appurtenant channels, two on each bank of the Mississippi River. On the east bank, structures would be located at Bohemia and Caernarvon. The Caernarvon structure was originally to be located at Scarsdale, but was moved to Caernarvon at the joint request of the St. Bernard Parish Police Jury and the Plaquemines Parish Commission Council. Structures on the west bank would be located in the vicinity of Myrtle Grove and Homeplace. The authorized project sites were reanalyzed instead of being considered in place because substantial time has elapsed since authorization. The present study of other diversion sites was an opportunity to either verify the authorized plan or develop a comprehensive plan that could be more readily implemented.

B.1.16. The potential sites were screened to determine the most feasible site from an engineering, economic, and environmental viewpoint. Order-of-magnitude type engineering, environmental, economic, and social assessments were made at most of the potential sites. The engineering assessment consisted of a preliminary hydraulic design, structure and channel design, hydraulic efficiency, and foundation considerations such as erosion, settling, seepage, and structure and channel costs. The environmental, economic, and social assessments used available reports, file data, maps, infrared photography, and ground reconnaissance to appraise serious impacts on important habitat types, water quality, cultural resources, businesses, residences, and existing facilities.

B.1.17. The Bohemia site originally included in the authorized Mississippi Delta Region project was eliminated because local interests constructed two diversion control structures at Bayou Lamoque, 3 1/2 miles downstream from the Bohemia site, after authorization. Thus, the need for the site at Bohemia was eliminated. The Homeplace site originally included in the authorized project was also eliminated. This site would be least effective in producing benefits because of its location at the lower end of the Barataria Basin. Table B-1-3 presents a summary of the pertinent engineering characteristics of the 19 remaining potential freshwater diversion sites. Plate B-1 shows site locations. Table B-1-4 is a summary of the potential construction impacts associated with the freshwater diversion sites.

B.1.18. The Breton Sound sites, Caernarvon Canal and Big Mar, were assessed and the impacts compared. Based on the assessment, Big Mar, with a shorter conveyance channel, would have fewer adverse impacts and would be less costly than Caernarvon Canal. Construction at Big Mar would have less effect on development and habitat. The adverse effect on water quality would be less severe because the diverted flow would be dispersed through more numerous interconnecting waterways in the marsh, allowing the freshwater to be detained longer. The longer detention period would provide time for pollutants to settle and the cooler river water to warm before entering the warmer brackish water bodies. Local officials have expressed support for the Big Mar site. Since these sites are within 1/2-mile of each other and are only variations of a single plan, the Big Mar site was selected for detailed analysis.

B.1.19. In Barataria Basin, the 17 possible diversion sites can be categorized in three groups with generally similar characteristics and conditions. The three groups are sites with Lac Des Allemands as the receiving water body, sites with Lake Cataouatche as the receiving water body, and sites with Bayou Barataria and Barataria Bay as the receiving water body.

TABLE B-1-3

SUMMARY OF PERTINENT ENGINEERING CHARACTERISTICS OF POSSIBLE DIVERSION SITES

Possible Site/ Receiving Water Body	Hydraulic Head (Feet) 1/	Channel Length (Feet)	Hydraulic Slope 2/ (Feet/Foot)	Structure Design and Foundation Factors	Drainage System Alteration	Relocation Design
BRETON BASIN						
Caernarvon Canal/ Lake Lery	3.0	28,000	0.00011	Erosion, Seepage, Settlement, Earthern Cofferdam Required	Minor	
Below Caernarvon Big Mar	3.0	8,000	0.00047	Erosion, Seepage, Earthern Cofferdam Required	Minor	
BARATARIA BASIN						
Bayou Bernel/ Lac Des Allemands	5.7	32,000	0.00018	Erosion, Seepage, Potential Liquefaction Failure, Required Earthern Cofferdam		
Johnson/Lac Des Allemands	5.7	32,000	0.00018	Erosion, Seepage, Settlement, Cellular Cofferdam Required		
Bayou Lasseigne/ Lac Des Allemands	5.6	31,000	0.00018	Potential Settlement, Cellular Cofferdam Required		
Bayou Fortier Lac Des Allemands	5.4	37,000	0.00015	Erosion, Potential Settlement, Earthern Cofferdam Required		
Lanaux Canal Lake Cataouatche	3.8	34,000	0.00011	Seepage, Settlement Cellular Cofferdam, Required	Major	
Sellers Canal Lake Cataouatche	3.8	32,000	0.00012	Seepage, Cellular Cofferdam Required	Major	
Saul's Canal Lake Cataouatche	3.8	39,000	0.00010	Erosion, Seepage, Settlement, Cellular Cofferdam Required	Major	
Willswood Canal Lake Cataouatche	3.5	33,000	0.00011	Erosion, Settlement, Cellular Cofferdam Required	Major	
Waggaman Canal Lake Cataouatche	3.4	34,000	0.00010	Erosion, Settlement, Cellular Cofferdam Required	Major	
Avondale Canal/ Lake Cataouatche	3.4	21,000	0.00016	Erosion, Settlement, Cellular Cofferdam Required	Major	
Bayou Segnette/ Lake Cataouatche	3.1	42,000	0.00007	Erosion, Seepage, Settlement, Cellular Cofferdam Required		
Harvey Lock Bayou Barataria	3.1	79,000	0.00004	Seepage, Settlement		Major
Algiers Lock Bayou Barataria	2.6	89,000	0.00003	Settlement		Major
[illegible] Canal Bayou Barataria	1.8	53,000	0.00003	Erosion, Settlement Cellular Cofferdam Required		
[illegible] Bayou Barataria	1.8	43,[illegible]	0.00004	Erosion, Potential Settlement, Cellular Cofferdam Required		
[illegible] [illegible] Canal	[illegible].8	[illegible]	[illegible]0.00003	Erosion, Seepage Settlement		
Davis Pond Lake [illegible]	[illegible]	12,[illegible]	[illegible]	Erosion, Seepage Settlement	Major	Major

1/ Hydraulic head represents difference between stages in river and tailwater area.

2/ Hydraulic slope represents ratio of hydraulic head to channel length.

TABLE B-1-4

POTENTIAL CONSTRUCTION IMPACTS ASSOCIATED WITH POSSIBLE DIVERSION SITES

[illegible]	Habitats Altered	Water Quality Degraded	Cultural Resources	Social and Economic	Facilities Requiring Relocation or Alteration: Highway	Railroad	Aerial Powerline & Submarine Cable	Pipeline	Canals
BRETON BASIN									
[illegible]	[illegible] miles benthic communities, [illegible] acres mixed wooded swamp and bottomland hardwood forest, [illegible] acres intermediate brackish marsh, and [illegible] acres developed lands.	Increased turbidity, decreased water temperature in Lake Lery. Zinc, mercury and fecal coliform bacteria may exceed EPA marine water criteria.	High probability of uncovering cultural resources, Caernarvon Plantation and six Indian mounds in area.	Economic: 12 acres developed lands lost. Social: Relocate 6 residences and 1[illegible] commercial establishments; disrupt transportation patterns; social and esthetic concerns to nearby residents, interfere with navigation.	One 2-lane	1		3	2 Drainage & 1 Navigation.
[illegible]	[illegible] miles benthic communities, [illegible] acres mixed wooded swamp and bottomland hardwood forest, [illegible] acres intermediate marsh, and 7 acres developed lands.	Similar to Caernarvon Canal. Some pollutants and sediments will settle out, and water will warm up during dispersion & long detention time.	High probability uncovering cultural resources, Caernarvon Plantation in area.	Economic: 7 acres developed lands lost.	One 2-lane	[illegible]	[illegible]	3	1 Drainage
BARATARIA BASIN									
[illegible]	[illegible] benthic communities, 152 acres wooded swamp, 46 acres of bottomland hardwood forest, 46 acres of fresh marsh, and [illegible] acres agricultural lands.	Increased turbidity, decreased water temperatures in Lac Des Allemands. Copper, zinc, mercury and fecal coliform bacteria may exceed recommended EPA marine criteria. Some pollutants and sediments will settle out and water will warm up during dispersion & long detention time.	High probability of uncovering cultural resources; historic sites Evergreen, Whitney, and Becnel Plantations.	Economic: 122 acres agricultural land lost.	One 2-lane	1	[illegible]	2	2 Drainage
[illegible]	[illegible] miles benthic communities, [illegible] acres wooded swamp, 46 acres fresh marsh, and 122 acres agricultural lands.	Same as Bayou Becnel.	High probability of uncovering cultural resources; historic sites Carroll and Wezo Plantations.	Economic: 122 acres agricultural land lost.	One 2-lane	1	[illegible]	2	2 Drainage
[illegible]	[illegible] miles benthic communities, [illegible] acres wooded swamps, 91 acres of fresh marsh, and [illegible] acres of agricultural lands.	Same as Bayou Becnel.	High probability of uncovering cultural resources; several historic structures in vicinity.	Economic: 61 acres agricultural land lost.	One 2-lane One local road	1		2	1 Drainage
[illegible]	[illegible] miles benthic communities, [illegible] acres wooded swamp; 76 acres bottomland hardwood forest; 122 acres fresh marsh; and 91 acres agricultural lands.	Same as Bayou Becnel.	High probability of uncovering cultural resources, Kennemore Plantation in channel R/W; several historic structures in vicinity.	Economic: 91 acres agricultural land lost.	One 2-lane One 4-lane One local road.	1		2	2 Drainage
[illegible]	2.3 miles benthic communities, 212 acres wooded swamp and bottomland hardwood forest, 93 acres fresh marsh; and 47 acres agricultural and developed lands.	Increased turbidity; cadmium zinc, mercury, and fecal coliform bacteria may exceed EPA marine criteria.	High probability of uncovering cultural resources.	Economic: 40 acres agricultural and developed land lost.	One 4-lane One 2-lane	2	[illegible]	2	5 drainage 21 navigation.

Potential Site	Habitats Altered	Water Quality Degraded	[illegible]	[illegible]	Facilities Requiring Relocation or Alteration: Highway	Railroad	Aerial Powerline & Submarine Cable	Pipeline	Canals
[illegible]	[illegible] miles benthic communities, [illegible] acres wooded swamp, [illegible] acres fresh marsh, and [illegible] acres agricultural lands.	Increased turbidity, decreased water temperatures [illegible]. [illegible] data [illegible] cadmium, zinc, mercury, and fecal [illegible] bacteria may exceed EPA marine water criteria.	[illegible]	Economic: [illegible] acres agricultural land lost. Social: Possible esthetic concerns to nearby residents.	One [illegible]-lane / [illegible]-lane	[illegible]	[illegible]	[illegible]	4 Drainage
[illegible] Canal	[illegible] miles benthic communities, [illegible] acres wooded swamp, [illegible] acres fresh marsh, and [illegible] acres of agricultural lands.	Same as [illegible]	[illegible]	Economic: [illegible] acres agricultural land [illegible]. Social: May have social and esthetic concerns to nearby residents.	One 2-lane / One [illegible]-lane	2	[illegible]	[illegible]	4 Drainage
[illegible] Canal	[illegible] miles benthic communities, [illegible] acres wooded swamps, [illegible] acres fresh marsh, and [illegible] acres agricultural lands.	Increased turbidity, decreased water temperatures [illegible] [illegible] bacteria may exceed EPA marine water criteria.	[illegible] probability of uncovering cultural resources [illegible] structures [illegible] Plantation.	Economic: [illegible] acres agricultural land lost. Social: [illegible] farm [illegible] would require relocation. May have esthetic concerns to nearby residents.	One 2-lane / One [illegible]-lane	2	1	4	4 Drainage
Willswood Canal	[illegible] miles benthic communities, [illegible] acres mixed wooded swamp and bottomland hardwood forest, [illegible] acres wooded swamp, [illegible] acres fresh marsh, and [illegible] acres agricultural lands.	[illegible] may exceed EPA marine water criteria.	Likely significant cultural resources, Willswood Plantation [illegible] channel R/W.	Economic: [illegible] acres agricultural land lost. Channel crosses oil production area.	One 2-lane / One [illegible]-lane	2	1	4	4 Drainage
Waggaman Canal	[illegible] miles benthic communities, [illegible] acres mixed wooded swamp and bottomland hardwood forest, [illegible] acres wooded swamp, [illegible] acres fresh marsh, and [illegible] acres agricultural lands.	Same as Willswood Canal.	Likely significant cultural resources, Willswood Plantation [illegible] channel R/W.	Economic: [illegible] acres agricultural land lost. Channel crosses an oil production area. Social: Relocate [illegible] residents and may have social and esthetic concerns to nearby residents.	One 2-lane / One [illegible]-lane	2	1	4	4 Drainage
Avondale Canal	[illegible] miles benthic communities, [illegible] acres wooded swamps, [illegible] acres fresh marsh, [illegible] and developed lands.	Same as [illegible]	High probability of uncovering cultural resources, Avondale Plantations in area.	Economic: [illegible] acres [illegible] cultural and developed lands lost. Channel crosses an oil production area. Social: Relocate [illegible] residences, disrupt transportation patterns and raise social and esthetic concerns of nearby residents.	One [illegible]-lane / [illegible]-lane	[illegible]	1	4	3 Drainage
Bayou Segnette	[illegible] miles benthic communities, [illegible] acres wooded swamp, [illegible] acres bottomland hardwood forest, [illegible] acres fresh marsh, [illegible] developed lands.	Same as Willswood Canal.	Low probability of cultural resources.	Economic: [illegible] acres of developed land lost. Channel crosses an oil and gas production area. Social: Relocate [illegible] residences, [illegible] commercial [illegible] industrial establishments and one barge facility. Disrupt transportation patterns [illegible] social and esthetic [illegible] residents.	One 2-lane / One [illegible]-lane	2	[illegible]	4	2 Drainage & 1 Navigation
Harvey Lock	[illegible] miles benthic communities, [illegible] acres mixed wooded swamp and bottomland hardwood forests, [illegible] acres wooded swamp, and [illegible] acres fresh marsh.	Increased [illegible] increased turbidity, decreased water temperatures [illegible] cadmium, lead, [illegible] may exceed EPA marine water criteria.	Low probability of cultural resources, several [illegible] structures [illegible]	Economic: [illegible] operations would delay navigation through lock. Social: Relocate [illegible] commercial and industrial structures [illegible] docking facilities and [illegible] boat slips.	Three 2-lane highways	[illegible]	1	14	2 Navigation
Algiers Lock	16.9 miles benthic communities, 261 acres mixed wooded swamp and bottomland hardwood forest, 91 acres wooded swamp; and 109 acres fresh marsh.	Similar to Harvey Lock. Fecal coliform bacteria may exceed EPA water criterion.	Low probability of cultural resources, several historic structures nearby.	Economic: Changes to lock operations would delay navigation through lock. Social: Relocate 1 boat slip and 12 docking facilities.	Two 2-lane	[illegible]	1	14	2 Navigation

TABLE B-1-4 (CONT'D)

SUMMARY OF POTENTIAL IMPACTS ASSOCIATED WITH FRESHWATER DIVERSION SITES (CONT'D)

Possible Site	Habitats Altered	Water Quality Degraded	Cultural Resources	Social and Economic	Facilities Requiring Relocation or Alteration: Highway	Railroad	Aerial Powerline Submarine Cable	Pipeline	Canals
Hero Canal.	[illegible] miles benthic communities; 146 acres mixed wooded swamp and bottomland hardwood forest; 91 acres wooded swamp, 109 acres fresh marsh, and 90 agricultural and developed lands.	Similar to Harvey Lock. Fecal coliform bacteria may exceed EPA water criteria.	High probability of cultural resources; several old plantations in area.	Economic: 90 acres of agricultural and developed lands lost. Social: Relocate 2 residents 4 commercial establishments, 1 boat slip, and 2 docking facilities in river, social and esthetic concerns to nearby residents.	One 2-lane	1	[illegible]	[illegible]	2 Naviga-
Oakville	2.5 miles benthic communities; 118 acres mixed wooded swamp and bottomland hardwood forest; 74 acres wooded swamp; 109 acres fresh marsh; and 23 acres agricultural and developed lands.	Increased pollutants, increased turbidity, decreased water temperatures in Bayou Barataria. Zinc, mercury and fecal coliform bacteria may exceed EPA marine water criteria.	High probability of cultural resources; several old plantations in area.	Economic: 23 acres of agricultural and developed lands lost. Social: Relocate 3 commercial establishments.	One 4-lane	1	0	1	1 Drainage & 1 Navigation
Myrtle Grove	8.4 miles benthic communities; 23 acres bottomland hardwood forest; 211 acres brackish and 70 acres of agricultural and developed lands.	Increased pollutants, increased turbidity, decreased water temperatures in Barataria Bay. Zinc, mercury and fecal coliform bacteria may exceed EPA marine water criteria.	High probability of uncovering cultural remains; several archeological sites in area.	Economic: 70 acres of agricultural and developed lands lost. Social: Relocate 7 camps.	One 4-lane	1	0	1	1 Drainage & 1 Navigation

B.1.20. The group of sites with Lac Des Allemands as the receiving water body are Bayous Becnel, Lasseigne, and Fortier, and the community of Johnson. Lake Cataouatche group of sites includes Lanoux Canal, Sellers Canal, Saul's Canal, Willswood Canal, Waggaman Canal, Avondale Canal, and Bayou Segnette. The Davis Pond site was added to the Lake Cataouatche group in August 1982. The third group of sites is farthest down-river and includes Harvey Lock, Algiers Lock, Hero Canal, and the communities of Oakville and Myrtle Grove.

B.1.21. Sites in the Lac Des Allemands group are more desirable than sites in the other two groups. Using these sites, the flow of diverted water into the basin would be dispersed to the maximum extent. The runoff rate would be slower, detaining the diverted flows for the longest period of time. The longer detention time would permit nutrients and sediments to be trapped and the cooler river water to warm before entering the brackish water bodies. From an environmental perspective, these sites produce greater outputs in terms of intangible benefits to fresh/intermediate, brackish, and saline areas in the basin.

B.1.22. The four sites in the Lac Des Allemands group were assessed and the Bayou Lasseigne and Bayou Fortier sites were retained for plan formulation. The Bayou Becnel and Johnson sites were eliminated. The sites retained are at relatively stable river locations while the other sites are in an eroding bend. Potential design and foundation problems of erosion, seepage, and settlement, and the potential for liquification-type failures were more severe at the sites eliminated. Construction impacts on the environment, water quality, and cultural resources and economic and social impacts slightly favor the sites retained. The sites retained were also estimated to be the least costly.

B.1.23. The Lake Cataouatche sites do not have the advantages of the Bayou Lasseigne and Bayou Fortier sites and are, therefore, less

desirable than the sites in the Lac Des Allemands group. In addition, the Lake Cataouatche sites have lower hydraulic heads and flatter hydraulic slopes, which translates into larger, more costly diversion structures and cross-sectional areas in the delivery channels. A major disadvantage of the eight sites as compared to all others is the close proximity to urbanized areas or areas where urban expansion is expected. The delivery channels of seven of the sites would each bisect a leveed, pumped drainage system. The Davis Pond site bisects a number of gravity drainage systems. With each of the sites, the delivery channels would have to be leveed and a pumping station added to the intercepted portion of the drainage areas. In view of these factors, seven of the eight sites were eliminated from further consideration.

B.1.24. The Davis Pond site offers some distinct advantages. The freshwater would enter a low, marsh area that includes the northern portion of the state-owned Salvador Wildlife Management Area. The flow could be detained in the area with a system of levees and weirs. Detaining the water in the overflow area would minimize such water quality impacts as water temperature on aquatic organisms. A major disadvantage is the proximity to an urbanizing area. The Davis Pond site crosses five gravity drainage systems. This routing would require the delivery channel to be leveed and a pumping station to be added to the intercepted portion of the drainage area. The Davis Pond site would be more expensive than the Lac Des Allemands site. However, it would achieve the planning objectives and it has public support. Thus, Davis Pond was carried into detailed planning.

B.1.25. The five lower sites, Harvey Lock, Algiers Lock, Hero Canal, Oakville, and Myrtle Grove, do not have the advantages of the Lac Des Allemands sites. However, these sites do have the advantage of discharging almost directly into saline areas, thereby providing a means for reacting quickly to saltwater intrusion during dry periods. The Oakville site would have the shortest delivery channel of all sites.

of the marsh, land enhancement, increased business opportunities in fish and wildlife-related industries, and increased tax revenues.

B.2.6. The point at which the diverted flows are introduced into the basin is an important aspect of each plan. The point of introduction determines the dispersion of flow in the basin, the area benefited, the detention time, and water quality impacts. In Plans 1 through 5, all of the diverted flow is introduced at the upper end of the basins. Plans 6 through 10 divert flows in the upper end of Barataria Basin and in the lower portion of the basin. Plans 11 through 15 divert flows at the upper and lower ends of Barataria Basin. Plan 16 diverts flows in the middle of Barataria Basin.

B.2.7. The upper basin diversion would permit the flows to spread over the largest area and range of habitat types. This dispersion would provide a flushing action throughout the basin and increase nutrients and sediments. The flows would be detained longer in the basin, which would permit the cooler and poorer quality river water to be more completely assimilated before reaching the highly sensitive estuarine shellfish habitat. Plans with all diversion in the upper basin provide the highest intangible benefits.

B.2.8. The intangible beneficial effects of plans that divert flows through a combination of sites in upper and middle Barataria Basin or through a single site in the middle of the basin are slightly less than the effects of plans that divert all flows in the upper basin. Flows diverted at the middle of the basin would not directly benefit habitat in the upper basin. However, they would benefit midbasin habitat that would be bypassed by flows into the upper basin. The detention time would be shorter and lower quality river water would be introduced in closer proximity to shellfish. Flows would be more rapidly dissipated in the saline waters of the gulf. To compensate for rapid dissipation of the freshwater, minor releases would be required later in the year

TABLE B-2-3

SUMMARY OF AVERAGE ANNUAL MONETARY BENEFITS

Category	Breton Sound Basin	Barataria Basin	Total
mercial Fishing		($1,000)	
Oysters	5,416	8,783	14,199
Shrimp	130	426	556
Menhaden	5	90	95
Other 1/	7	46	53
Total	5,558	9,345	14,903
mercial Wildlife			
Furbearers 2/	109	46	155
Alligators	76	60	136
Total	185	106	291
rt Fishing and Hunting			
Fishing	37	98	135
Hunting	274	161	435
Total	311	259	570
'AL	6,054	9,710	15,764

Includes blue crab, croaker, seatrout, spot, and red drum.
Includes nutria, muskrat, mink, otter, and raccoon.

TABLE B-2-2

SUMMARY COSTS FOR ALTERNATIVE PLANS

Plans	Basin Element	Flows (CFS)	First Cost 1/	Annual Operations & Maintenance 2/	Annual Cost
				$1,000	
1	Big Mar	6,600	15,300	144	1,500
	Bayou Fortier	7,100	23,900	210	2,350
	Bayou Lasseigne	3,550	14,700	170	1,470
	Totals		53,900	524	5,320
2	Big Mar	6,600	15,300	144	1,500
	Bayou Fortier	3,550	15,200	170	1,510
	Bayou Lasseigne	7,100	22,200	210	2,200
	Totals		52,700	524	5,100
3	Big Mar	6,600	15,300	144	1,500
	Bayou Fortier	5,325	20,200	193	2,000
	Bayou Lasseigne	5,325	18,400	193	1,820
	Totals		53,900	530	5,320
4	Big Mar	6,600	15,300	144	1,500
	Bayou Fortier	10,650	32,300	327	3,200
	Totals		47,600	471	4,700
5	Big Mar	6,600	15,300	144	1,500
	Bayou Lasseigne	10,650	28,900	327	2,900
	Totals		44,200	471	4,400
6	Big Mar	6,600	15,300	144	1,500
	Oakville	5,325	11,100	144	1,140
	Bayou Fortier	5,325	20,600	216	2,040
	Totals		47,000	504	4,680
7	Big Mar	6,600	15,300	144	1,500
	Oakville	5,325	11,100	144	1,150
	Bayou Lasseigne	5,325	18,700	216	1,880
	Totals		45,300	504	4,530
8	Big Mar	6,600	15,300	144	1,500
	Oakville	3,550	8,100	126	850
	Bayou Fortier	7,100	24,300	232	2,390
	Totals		47,700	502	4,740
9	Big Mar	6,600	15,300	144	1,500
	Oakville	3,550	8,100	126	850
	Bayou Lasseigne	7,100	22,700	232	2,250
	Totals		46,100	502	4,600
10	Big Mar	6,600	15,300	144	1,500
	Oakville	3,550	8,000	103	810
	Bayou Fortier	3,550	15,100	153	1,500
	Bayou Lasseigne	3,550	14,700	153	1,470
	Totals		53,100	553	5,280
11	Big Mar	6,600	15,300	144	1,500
	Myrtle Grove	5,325	12,600	144	1,250
	Bayou Fortier	5,325	20,500	216	2,060
	Totals		48,400	504	4,810
12	Big Mar	6,600	15,300	144	1,500
	Myrtle Grove	5,325	12,600	144	1,260
	Bayou Lasseigne	5,325	18,800	216	1,890
	Totals		46,700	504	4,650
13	Big Mar	6,600	15,300	144	1,500
	Myrtle Grove	3,550	9,600	125	940
	Bayou Fortier	7,100	24,200	233	2,430
	Totals		49,100	502	4,870
14	Big Mar	6,600	15,300	144	1,500
	Myrtle Grove	3,550	9,600	125	960
	Bayou Lasseigne	7,100	22,600	233	2,260
	Totals		47,500	502	4,720
15	Big Mar	6,600	15,300	144	1,500
	Myrtle Grove	3,550	9,400	103	950
	Bayou Fortier	3,550	15,100	153	1,490
	Bayou Lasseigne	3,550	14,700	153	1,460
	Totals		54,500	553	5,400
16	Big Mar	6,600	15,300	144	1,500
	Davis Pond	10,650	32,100	401	3,260
	Totals		47,400	545	4,760

1/ Preconstruction and postconstruction monitoring costs were apportioned between the diversion sites in the Barataria Basin. The total construction cost per site will vary and depends on the number of diversion sites proposed for the basin.

2/ The operation and maintenance (O&M) costs of the monitoring program for the Barataria Basin were apportioned between the diversion sites. The total of O&M costs per site will vary and depends on the number of diversion sites proposed for the basin.

Alternative Plan	Diversion Site	Flow (cfs)	Inflow Channel Bottom Elev. 1/ (FEET)	Inflow Channel Bottom Width (FEET)	Inflow Channel Length (FEET)	Control Structure Invert Elev. 1/ (FEET)	Box Culverts No.	Box Culverts Size (FEET)	Box Culverts Length (FEET)	Outflow Channel Bottom Elev. (FEET)	Outflow Channel Bottom Width (FEET)	Outflow Channel Length (FEET)	Land Required Structure & Channel (ACRES)	Land Required Levee & Disposal (ACRES)	Excavated Material Construction (CUBIC YARDS)	Excavated Material Maintenance Annual (CUBIC YARDS)	Relocations Required Roads	Relocations Required Railroads	Relocations Required Pipelines
1	Big Mar	6,600	-2.0	200	800	-2.0	9	5x20	100	-6.0	180	8,100	50.6	74.2	164.0	3.1	1	1	3
	Bayou Fortier	7,100	-6.0	120	5,900	-6.0	4	12x20	200	-5.5/-11.0	100-200	30,220	240.5	380.0	3,970.0	29.3	3	1	2
	Bayou Lasseigne	3,550	-4.0	60	560	-4.0	2	12x20	200	-3.5/9.5	40-80	32,080	147.7	246.0	2,098.7	14.7	2	1	2
2	Big Mar	6,600	-2.0	200	800	-3.0	9	5x20	100	-6.0	180	8,100	50.6	74.2	164.0	3.1	1	1	3
	Bayou Fortier	3,550	-5.5	60	5,900	-6.0	2	12x20	200	-5.0/10.0	60-100	30,220	167.0	275.0	1,850.0	14.7	3	1	2
	Bayou Lasseigne	7,100	-5.0	100/120	560	-4.0	4	12x20	200	-4.5/11.5	80-160	32,080	212.3	352.0	4,091.3	29.3	2	1	2
3	Big Mar	6,600	-2.0	200	800	-3.0	9	5x20	100	-6.0	180	8,100	50.6	74.2	164.0	3.1	1	1	3
	Bayou Fortier	5,325	-5.5	100	5,900	-6.0	3	12x20	200	-5.0/10.5	80-160	30,220	210.2	349.0	3,290.0	22.0	3	1	2
	Bayou Lasseigne	5,325	-4.0	80/100	560	-4.0	3	12x20	200	-4.0/10.5	60-120	32,080	182.0	303.0	3,164.8	22.0	2	1	2
4	Big Mar	6,600	-2.0	200	800	-3.0	9	5x20	100	-6.0	180	8,100	50.6	74.2	164.0	3.1	1	1	3
	Bayou Fortier	10,650	-6.0	200	5,900	-6.0	6	12x20	200	-5.0/14.0	160-240	30,220	292.1	488.0	6,110.0	44.0	3	1	2
5	Big Mar	6,600	-2.0	200	800	-3.0	9	5x20	100	-6.0	180	8,100	50.6	74.2	164.0	3.1	1	1	3
	Bayou Lasseigne	10,650	-5.0	160/200	560	-4.0	6	12x20	200	-5.0/12.0	120-200	32,080	246.0	407.2	5,143.7	44.0	2	1	2
6	Big Mar	6,600	-2.0	200	800	-3.0	9	5x20	100	-6.0	180	8,100	50.6	74.2	164.0	3.1	1	1	3
	Oakville	5,325	-8.5	120	160	-8.0	4	12x20	100	-1.0/-13.0	120/160	38,880	119.4	157.0	1,176.0	21.0	1	1	1
	Bayou Fortier	5,325	-5.5	100	5,900	-6	3	12x20	200	-5.0/-10.5	80/160	30,220	210.2	349.0	3,290.0	22.0	3	1	2
7	Big Mar	6,600	-2.0	200	800	-3.0	9	5x20	100	-6.0	180	8,100	50.6	74.2	164.0	3.1	1	1	3
	Oakville	5,325	-8.5	120	160	-8.0	4	12x20	100	11.0/-13.0	120/160	38,800	119.4	157.0	1,176.0	21.0	1	1	1
	Bayou Lasseigne	5,325	-4.0	80/100	560	-4.0	3	12x20	200	-4.0/10.5	60/120	32,080	182.0	303.0	3,164.8	22.0	2	1	2
8	Big Mar	6,600	-2.0	200	800	-3.0	9	5x20	100	-6.0	180	8,100	50.6	74.2	164.0	3.1	1	1	3
	Oakville	3,550	-9.5	60	160	-8.0	2	12x20	100	-9.5/13.0	120 160	38,880	91.3	124.0	616.0	14.0	1	1	1
	Bayou Fortier	7,100	-6.0	120	5,900	-6.0	4	12x20	200	-5.5/11.0	100/200	30,220	240.5	380.0	3,970.0	29.3	3	1	2
9	Big Mar	6,600	-2.0	200	800	-3.0	9	5x20	100	-6.0	180	8,100	50.6	74.2	164.0	3.1	1	1	3
	Oakville	3,550	-9.5	60	160	-8.0	2	12x20	100	-9.5/-13.0	120-160	38,880	91.3	124.0	616.0	14.0	1	1	1
	Bayou Lasseigne	7,100	-5.0	100/120	560	-4.0	4	12x20	200	-4.5/-11.5	80-160	32,080	212.3	352.0	4,091.3	29.3	2	1	2
10	Big Mar	6,600	-2.0	200	800	-3.0	9	5x20	100	-6.0	180	8,100	50.6	74.2	164.0	3.1	1	1	3
	Oakville	3,550	-9.5	60	160	-8.0	2	12x20	100	-9.5/13.0	120-160	38,880	91.3	124.0	616.0	14.0	1	1	1
	Bayou Fortier	3,550	-5.5	60	5,900	-6.0	2	12x20	200	-5.0/10.0	60-100	30,220	167.0	275.0	1,850.0	14.7	3	1	2
	Bayou Lasseigne	3,550	-4.0	60	560	-4.0	2	12x20	200	-3.5/9.5	40-80	32,080	147.7	246.0	2,098.7	14.7	2	1	2
11	Big Mar	6,600	-2.0	200	800	-3.0	9	5x20	100	-6.0	180	8,100	50.6	74.2	164.0	3.1	1	1	3
	Myrtle Grove	5,325	-10.5	120	500	-10.0	4	13x20	100	-13.0/250	50-250	43,600	219.5	297.1	1,377.0	21.0	1	1	1
	Bayou Fortier	5,325	-5.5	100	5,900	-6.0	3	12x20	200	-5.0/-10.5	80-160	30,220	21.02	349.0	3,290.0	22.0	3	1	2
12	Big Mar	6,600	-2.0	200	800	-3.0	9	5x20	100	-6.0	180	8,100	50.6	74.2	164.0	3.1	1	1	3
	Myrtle Grove	5,325	-10.5	120	500	-10.0	4	13x20	100	-13.0/-15.0	50-250	43,600	219.5	297.1	1,377.0	21.0	1	1	1
	Bayou Lasseigne	5,325	-4.0	80/100	560	-4.0	3	12x20	200	-4.0/-10.5	60-120	32,080	182.0	303.0	3,164.8	22.0	2	1	2
13	Big Mar	6,600	-2.0	200	800	-3.0	9	5x20	100	-6.0	180	[illegible]	50.6	74.2	[illegible]	3.1	1	1	3
	Myrtle Grove	3,550	11.5	60	500	-10.0	2	13x20	100	-13.0/-15.0	50-250	43,600	213.9	289.3	1,224.0	14.0	1	1	1
	Bayou Fortier	7,100	-6.0	120	5,900	-6.0	4	12x20	200	-5.5/-11.0	100-200	30,220	240.5	380.0	3,970.0	29.3	3	1	2
14	Big Mar	6,600	-2.0	200	800	-3.0	9	5x20	100	-6.0	180	8,100	50.6	74.2	164.0	3.1	1	1	3
	Myrtle Grove	3,550	-11.5	60	500	-10.0	2	13x20	100	-13.0/15.0	50-250	43,600	213.9	289.3	1,224.0	14.0	1	1	1
	Bayou Lasseigne	7,100	-5.0	100/200	560	-4.0	4	12x20	200	-4.5/11.5	80-160	32,080	212.3	352.0	4,091.3	29.3	2	1	2
15	Big Mar	6,600	-2.0	200	800	-3.0	9	5x20	100	-6.0	180	8,100	50.6	74.2	164.0	3.1	1	1	3
	Myrtle Grove	3,550	11.5	60	500	-10.0	2	13x20	100	-13.0/15.0	50-250	43,600	213.9	289.3	1,224.0	14.0	1	1	1
	Bayou Fortier	3,550	-5.5	60	5,900	-6.0	2	12x20	200	-5.0/10.0	60-100	30,220	167.0	275.0	1,850.0	14.7	3	1	2
	Bayou Lasseigne	3,550	-4.0	60	560	-4.0	2	12x20	200	-3.5/-9.5	40-80	32,080	147.7	246.0	2,098.7	14.7	2	1	2
16	Big Mar	6,600	-2.0	200	800	-3.0	9	5x20	100	-6.0	180	8,100	50.6	74.2	164.0	3.1	[illegible]	[illegible]	3
	Davis Pond	10,650	-10.0	200	520	-10.0	6	15x15	240	-10/-12	200	11,250	97.0	463.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

1/ Elevations are in feet National Geodetic Vertical Datum formerly referred to as mean sea level.

a maximum of 15 feet high within the rights-of-way. Pertinent design data including dimensions of the control structures, inflow and outflow channels, land requirements, amount of excavated material, and relocations required by each plan are presented in table B-2-1.

B.2.4. Table B-2-2 contains a summary of the estimated first cost, annual operations and maintenance cost, annual cost of the elements of each plan, and the total for each of the 16 plans. Detailed information on the estimated costs is in Appendix C, Engineering Investigations.

B.2.5. The benefits produced by each plan are based primarily on retarding saltwater intrusion, enhancing vegetative growth, reducing land loss, and expanding nursery grounds. The average annual monetary benefits for each plan is $15,764,000. These average annual benefits consist of $15,194,000 attributable to enhancement of commercial fisheries and wildlife and $570,000 to sport fishing and hunting. Table B-2-3 presents a summary of the benefits for the Barataria and Breton Sound Basins. The marsh habitat saved over a 50-year project life is estimated at 16,472 acres in Breton Sound and 82,690 acres in Barataria Basin. The plans affect about 617,000 acres of receiving water bodies in the Barataria Basin and 365,000 acres in Breton Sound. The primary impacts on receiving water bodies are alteration of salinity regimes and other water quality parameters. The diverted flows will raise the mean water level of the receiving water bodies, but will have an insignificant impact on mean high water levels. The intangible benefits are numerous and the magnitude varies from plan to plan. The benefits include increased plant species diversity, improved habitat for nongame and noncommercial species, improved productivity of wooded swamps and associated freshwater fish and wildlife, and increased potential for recreation. Other benefits include the buffering effect of the marsh in reducing hurricane tides, the waste treatment capacity

Site	Outlet Channel
Big Mar	0.7 miles of land cut between structure and Big Mar
Bayou Lasseigne	6.1 miles of land cut between structure and Lac Des Allemands
Bayou Fortier	1.5 miles of land cut between structure and bayou, and enlargement of 4.3 miles of bayou
Davis Pond	2.1 miles of land cut between structure and overflow area
Oakville	2.3 miles of land cut between structure and Barataria Bay Waterway, and enlargement of 1.5 miles of waterway
Myrtle Grove	0.6 miles of land cut between structure and Wilkinson Canal, and enlargement of 7.7 miles of canal

The channels would be excavated by dragline or hydraulically dredged in open water areas. Excavated material would be placed in equal amounts on both sides of the channel to a maximum of 15 feet high within the rights-of-way except at the Big Mar and Davis Pond sites. At the Big Mar site, excavated material will also be used to construct a dike about 2 miles in length along the Caernarvon Canal to contain diverted flows. At the Davis Pond site, excavated material would be used to construct levees from the structure to the overflow area. Excess material would be placed in open water areas to create 175 acres of marsh in the overflow area. The overflow area would be bordered by 11.9 miles of levees that would be constructed with material dredged from along the levee rights-of-way. At the Bayou Lasseigne, Bayou Fortier, Oakville, and Myrtle Grove sites, excavated material would be placed to

Section 2. PRESENTATION AND ASSESSMENT OF PLANS

INTRODUCTION

B.2.1. The 16 alternative plans consist of combinations of various size flows at the Big Mar, Bayou Fortier, Bayou Lasseigne, Davis Pond, Oakville, and Myrtle Grove sites. Each plan proposes one diversion on the east bank of the Mississippi River and one or more on the west bank. All plans have a diversion at the Big Mar site on the east bank in common.

B.2.2. Site developments are generally similar. Each consists of a salinity control structure, inlet and outlet channels, and dispoal areas for excavated materials along both sides of the channels. The salinity control structures are multiple box culverts that vary in number and size in the array of plans. At the Big Mar, Bayou Lasseigne, Bayou Fortier, and Davis Pond sites, the salinity control structures would be located in the Mississippi River levee. At the Oakville and Myrtle Grove sites, the structure would be located landward of the existing levee because of the lack of adequate riverside berm to permit economical construction. The sites are shown on plates C-19 through C-24 in Appendix C, Engineering Investigations.

B.2.3. Inlet and outlet channels vary in cross section depending on location and size of flows diverted by each plan. The length of the inlet and outlet channels for a particular site is the same in each plan. All inlet channels would be new channels cut between the river and the structure. The outlet channels would use new land cuts and enlarged existing channels. The following tabulation describes the new land cut channels and existing channels required for the plans.

TABLE B-1-5

ALTERNATIVE COMBINATIONS OF SITES AND FLOWS

	Breton Sound	Barataria Basin				
	Big Mar	Oakville	Myrtle Grove	Davis Pond	Bayou Fortier	Bayou Lasseigne
Alternative Combinations	Percent of Flow					
1	100	0	0	0	67	33
2	100	0	0	0	33	67
3	100	0	0	0	50	50
4	100	0	0	0	100	0
5	100	0	0	0	0	100
6	100	50	0	0	50	0
7	100	50	0	0	0	50
8	100	33	0	0	67	0
9	100	33	0	0	0	67
10	100	33	0	0	33	33
11	100	0	50	0	50	0
12	100	0	50	0	0	50
13	100	0	33	0	67	0
14	100	0	33	0	0	67
15	100	0	33	0	33	33
16	100	0	0	100	0	0

shows the 16 alternative combinations of sites and flows that were developed based on the analysis. The 16 plans provide an array of alternatives for maximizing net benefits. In addition to the 16 action alternatives, a no-action plan was carried forward. The 16 alternative plans are shown on plate B-2.

condition determined that the Big Mar, Bayou Lasseigne, and Bayou Fortier sites could meet the requirements of the condition. The Davis Pond site is not able to meet the requirements of the condition if diversion is stopped at the end of April because the detention time of the flows is insufficient to maintain the desired salinities beyond August. However, the requirements could be met by extending the diversion period through May. Detention of the water in the 7,425-acre overflow area would improve water quality, allow water temperatures to equalize, and minimize adverse impacts on estuarine organisms. Thus, extending the diversion period through May at the Davis Pond site was considered acceptable. Neither the Oakville or the Myrtle Grove sites, by themselves, would be able to meet the requirements because the detention time of the flows after diversion is stopped at the end of April would be inadequate to maintain the desired salinities from June through September. Combining these two downstream sites with upstream sites would be effective. However, the flow contributed by the Oakville and Myrtle Grove sites could not exceed 50 percent of the total flow diverted.

B.1.38. In developing possible combinations of flows and sites, flows of 33, 50, 67, and 100 percent of the optimum 10,650 cfs flow to Barataria Basin were used for Bayou Lasseigne and Bayou Fortier sites. Flows of 33 and 50 percent of the optimum 10,650 cfs flow were used in plans that included the Oakville and Myrtle Grove sites. Plans were developed that combined flows from the Bayou Lasseigne and Bayou Fortier sites in the upper basin with the Oakville and Myrtle Grove sites in the lower basin. In an early plan formulation iteration, combining flows from sites in the upper and lower basin proved less desirable than diverting flow from a single upper basin site. It was also determined that combining lower basin sites with the Davis Pond site would be less desirable. Therefore, the Davis Pond site was evaluated for only the optimum flow. All plans include the Big Mar site with an optimum diversion flow of 6,600 cfs to the Breton Sound Basin. Table B-1-5

gradients, or improving water quality. Sanctuaries protect fish and wildlife species by preserving habitat and protecting the organisms during critical stages in their life cycles. Such protection increases productivity and reduces mortality. The measures would also reduce the commercial and sport harvest of the fish and wildlife resources. Because other measures would accomplish the planning objectives more extensively and without reducing harvest, the measure was not considered further.

MANAGE FISH AND WILDLIFE

B.1.36. Managing fish and wildlife populations by regulating harvest, stocking programs, planting cultch material for oyster culture, planting and propagating vegetation, and by controlled marsh burning would make a minor contribution to enhancing vegetative growth and moderate contributions to increasing fish and wildlife production. The plan would have virtually no effect on preserving and restoring wetlands, creating favorable salinity gradients, or improving water quality. This measure does not address the major problems and would have only minor outputs. Therefore, it was not considered further.

ALTERNATIVE PLANS

B.1.37. Freshwater diversion to Breton Sound Basin at the Big Mar site and to Barataria Basin at the Bayou Lasseigne, Bayou Fortier, Davis Pond, Oakville, and Myrtle Grove sites is the specific management measure used to develop plans. Innumerable plans are possible by combining various flows and sites. The objective of achieving the desired salinity conditions from April through September was used as a basic condition for development of plans. The condition requires a flow of 6,600 cfs to Breton Sound Basin and 10,650 cfs to Barataria Basin from January through April. With this condition, the number of possible plans are substantially reduced. Further analysis based on the imposed

B.1.32. The US Army Corps of Engineers administers a major regulatory program under authorities in Sections 9, 10, and 13 of the River and Harbor Act of 1899, Section 404 of the Clean Water Act, and Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972, as amended. Other Federal regulatory programs are administered by the US Environmental Protection Agency and agencies in the US Department of Interior.

B.1.33. The State of Louisiana has an approved coastal resources program. The program contains a comprehensive set of coastal zone management policies and an organized state and local government structure for implementing the policies and delineating the coastal zone boundary. Included in the state policies are a set of coastal use guidelines that, in effect, constitute a major regulatory program for the study area. Details of the state program are in the document entitled "Louisiana Coastal Resources Program Final Environmental Impact Statement" published by the Louisiana Department of Natural Resources, dated 1980.

B.1.34. The regulatory programs of the Federal and state government are comprehensive and capable of effectively regulating alterations that cause saltwater intrusion. The studies performed for this interim report could not identify any additional regulatory requirements that would contribute to these programs. Continued administration of the regulatory programs will provide a major contribution to meeting study objectives.

ESTABLISH SANCTUARIES

B.1.35. Establishing sanctuaries in important breeding, nursery, and feeding grounds would make a moderate contribution to preserving wetlands and increasing fish and wildlife production. It would have no effect on enhancing vegetative growth, creating favorable salinity

FILL OPEN WATER AREAS

B.1.28. Filling open water areas with dredged material obtained during maintenance dredging of navigation projects in the area would provide moderate contributions to restoring wetlands, enhancing vegetative growth, and increasing wildlife production, and a minor contribution to creating favorable salinity gradients. This measure is presently being implemented to a limited extent by the US Army Corps of Engineers.

B.1.29. The measure primarily addresses the major problem of extensive land and habitat loss. Filling open water areas with dredged material provides a partial solution. Dredged material placement should be investigated in combination with diversion of very large quantities of sediment-laden water and with measures that have the potential to reduce erosion and subsidence. A comprehensive study of possible solutions to the land loss problem is proposed under the overall Louisana Coastal Area study.

B.1.30. The measure makes only a minor contribution to creating favorable salinity gradients. The measure will be considered in future proposed studies. Therefore, it was not considered further in this interim report addressing salinity control.

REGULATE ALTERATION OF WETLANDS

B.1.31. The alteration of coastal wetlands that accompanies human activities has contributed significantly to saltwater intrusion and other environmental problems. As a result, regulating adverse alterations has been recognized as an effective means of protecting and preserving the environment. Federal, state, and local agencies have implemented programs that protect the public interest through regulation.

Construction impacts of the Oakville and Myrtle Grove sites would be less than the other Lake Cataouatche sites because there is less development in the general area. Thus, the Oakville and Myrtle Grove sites were retained for further consideration.

B.1.26. As a result of the assessment of potential sites, six sites were retained for plan formulation. The sites are Big Mar, Bayou Lasseigne, Bayou Fortier, Davis Pond, Oakville, and Myrtle Grove.

SALTWATER BARRIERS

B.1.27. Various types of saltwater barriers were investigated as a means of retarding saltwater intrusion. The barriers included a navigation lock in Barataria Bay Waterway, pneumatic barriers with sector gates in Bayou Perot, and navigable weirs and stoplog structures for an estimated nine oil field and other canals. A preliminary design and cost estimate was prepared for each type of structure. A typical navigation lock with a 100- by 1,200-foot chamber and a low sill elevation of 16 feet below National Ceodetic Vertical Datum (NGVD) was estimated to cost about $36 million. A pneumatic barrier with sector gates, a 40- by 150-foot chamber, and a low sill elevation of 10 feet below NGVD was estimated at about $12 million. A typical navigable weir and stoplog structure with 40-foot wide gates and a low sill elevation of 10 feet below NGVD was estimated at about $680,000. The primary adverse effect of the measure would be disruption of navigation and fish migration in certain areas. The measure would be costly to implement and would provide fewer benefits than freshwater diversion. Thus, it was eliminated from further consideration.

after water temperatures equalize. Including an overflow area at the Davis Pond site would minimize water quality impacts on estuarine organisms and permit diversion through May. An advantage of these diversions is that salinities could be influenced in a shorter period of time than with all upper basin diversion. The combination of upper and middle basin diversions would provide greater flexibility in controlling salinities. The Davis Pond site would also provide a shorter response time than an upper site.

B.2.9. Plans that divert flows in the upper and lower Barataria Basin would have the least effect on habitat in the upper basin. Flows diverted in the lower basin would introduce the cooler, lower quality river water directly into the highly sensitive estuarine shellfish-producing areas. However, the combination of upper and lower basin diversions would provide greater flexibility in controlling salinities.

COST-SHARING

B.2.10. The primary function of the plans is to enhance fish and wildlife resources by retarding saltwater irtrusion, enhancing vegetative growth, reducing land loss, and expanding nursery grounds. Traditional cost-sharing policies for enhancement of fish and wildlife stipulate that the first costs are to be shared on a 75-percent Federal and 25-percent non-Federal basis. Non-Federal interests must also assume all costs for operation, maintenance, and replacements. This is the basis for the Mississippi Delta Region project authorized by the Flood Control Act of 1965 and modified by the Water Resources Development Act of 1974. Tables B-2-4, B-2-5, and B-2-6 (show the Federal and non-Federal costs for each of the 16 alternative plans, which are consistent with the authorized Mississippi Delta Region project.

TABLE [illegible]

[illegible] PRESENTATION AND [illegible]

PLANS [illegible]

Item	Existing Condition 1980	Future Condition (No Action) 2035	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5
I. PLAN DESCRIPTION			Big Mar - 6,600 [illegible] Bayou Fortier - [illegible] Bayou Lasseigne - [illegible]	Big Mar - 6,600 [illegible] Bayou Fortier - 3,550 CFS Bayou Lasseigne - [illegible] CFS	Big Mar - 6,600 CFS Bayou Fortier - 5,325 CFS Bayou Lasseigne-5,325 CFS	Big Mar - 6,600 CFS Bayou Fortier 10,650 CFS	Big Mar- 6,600 CFS Bayou Lasseigne-10,650 CFS
II. SIGNIFICANT IMPACTS 1. National Economic Development (NED) 1/							
a. Total average annual benefits			$15,760,000	$15,760,000	$15,760,000	$15,760,000	$15,760,000
b. Total average annual costs			5,320,000	5,210,000	5,320,000	4,700,000	4,400,000
(1) Interest and amortization			4,796,000	4,686,000	4,790,000	4,229,000	3,929,000
(2) Operation and maintenance			524,000	524,000	530,000	471,000	471,000
c. First Cost			$52,900,000	$52,200,000	$53,000,000	$47,600,000	$44,200,000
d. Net annual NED benefits			10,440,000	10,550,000	10,440,000	11,060,000	11,360,000
e. Benefit-Cost ratio			3.0	3.0	3.0	3.4	3.6
2. Environmental Quality (EQ)							
a. Wetlands	881,100 acres of wetlands (657,400 acres of marsh).	488,100 acres of wetlands (376,500 acres of marsh).	9[illegible] acres of wetlands affected. [illegible] acres of marsh saved. (1,2,3,5,9)	Similar to plan 1	Similar to plan 1.	Similar to plan 1.	Similar to plan 1.
b. Water bodies 2/	982,000 acres of canals, lakes, bays, & sound.	1,262,900 acres of water.	1[illegible] acres altered. 5 sq mi delta formed. (1,2,3,5,9)	Similar to plan 1.	Similar to plan 1.	Similar to plan 1.	Similar to plan 1.
c. Water Quality*	Fresh to saline, warm. Trace metals-nutrients, fecal coliform bacteria occasionally exceed criteria.	Basin water quality degraded. 15 ppt isohaline 12 miles north in Barataria Bay, 17 miles in Breton Sound.	[illegible] into fresh lakes. Cool, increased turbidity, possible bioaccumulation of pollutants, fecal coliform (1,2,3,5,9)	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
d. Prime and unique farmland* and other lands.	Sugarcane land. Other includes disposal & developed areas.	Farmland converted to other uses in vicinity of urbanizing areas.	121 acres of farmland & 11 acres of other. (1,2,3,5,9)	Similiar to plan 1.	Similar to plan 4.	Similar to plan 1.	Similar to plan 1.
e. Endangered species	Bald eagle & brown pelican nest in area; Arctic peregrine falcon visitor.	Species adversely affected by habitat deterioration.	Poor water quality could affect species. (1,2,3,5,9)	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
f. Fish and Wildlife	$115,000,000 total income.	$66,000,000 total income.	$107,000,000 total income. (1,2,3,5,9)	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
g. National Register of Historic Places	None	None	None	None	None	None	None
3. Social Well-Being a. Community Cohesion*	Unique cultural heritage & life-styles dependent on fishing & trapping.	Preservation of life-styles & community cohesion difficult.	Help maintain traditional lifestyles. (1,2,3,5,9)	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
b. Community growth*	Dependent on the fish & wildlife industries.	Population & opportunities would decline.	Increase opportunities. (1,2,3,5,9)	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.

TABLE B-2[illegible] (CONTINUED)

SUMMARY PRESENTATION AND [illegible] OF ALTERNATIVE PLANS

Plans 1-5

Item	Existing Condition 1980	Future Condition (No Action) 2035	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5
c. Displacement of People*			None	None	None	None	None
Businesses			None	None	None	None	None
d. Leisure*	1,065,000 man-days of sport fishing & hunting.	868,000 man-days of sport fishing & hunting.	961,[illegible] man-days of sport fishing & hunting. (1,2,3,5,9	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
e. Property values*		Continued decline.	Slight increase.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
f. Tax Revenues*		Taxes derived from fish & wildlife activities would decline.	Reduced loss of taxes derived from wildlife activities. (1,2,3,5,9)	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
g. Transportation*			Minor disruption of vehicular traffic during construction. (1,2,3,5,9)	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
h. Noise*			Minor increase in noise levels during construction. (1,2,3,5,9)	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
i. Quality of community life			Increased opportunities aid in maintaining quality of life.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
4. Regional Development (RD)							
a. Employment and income		Continued decline in employment, & income in fish & wildlife related industries.	Minor increase during construction, operation, maintenance. Long-term increase in fish & wildlife related industries. (1,2,3,5,9)	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
b. Regional growth and businesses activity		Continued decline in activities related to fish and wildlife.	Revitalize declining fish & wildlife related industries.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
III. Plan Evaluation							
1. Contribution to Planning Objectives							
a. Increase fish and wildlife production (NED) 1.			Average annual net increase $15,760,000	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
b. Preserve and wetlands, enhance vegetative growth, establish favorable salinity gradients, improve sport fish and wildlife opportunities (EQ)			Positive contribution.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
2. Net Effects							
a. Net NED average annual benefits			$10,440,000	$10,550,000	$10,440,000	$11,060,000	$11,360,000
b. Net EQ effects			Highly positive	Highly positive	Highly positive	Highly positive	Highly positive
c. Net Social Well-Being Effects			Slightly positive	Slightly positive	Slightly positive	Slightly positive	Sightly positive
d. Net Regional Development Effects			Slightly positive	Slightly positive	Slightly positve	Slightly positive	Slightly positive

TABLE B-2-4 (CONTINUED)

SUMMARY PRESENTATION AND ASSESSMENT OF DETAILED PLANS

Plans 1-5

Item	Existing Condition 1982	Future Condition (No Action) 2035	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5
3. Plan Response to Associated Evaluation Criteria							
a. Acceptability			Local interests oppose Lac Des Allemands site.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
b. Efficiency			Less efficient than plans 4,5 & 16 due to coordination in maintaining best flow combination. More efficient than plans 6-15.	Same as plan 1.	Same as plan 1.	More efficient than 1, 2, & 3; comparable to plan 5 & 16; more efficient than plans 6-15.	Most efficient plan.
c. Geographic scope			Maintains desired conditions over largest area.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
d. NED benefit-cost ratio			3.0	3.0	3.[illegible]	3.[illegible]	3.[illegible]
e. Reversability			Less reversible than plans 4, 5, 16, same 2-3, 6-9, 11-14, more reversible than 10 & 15.	Same as plan 1.	Same as plan 1.	Most reversible.	Same as plan 4.
4. Rankings of plans							
a. NED Objectives			14	12	15	6	1 NED plan.
b. EQ objectives			6	5	4	3	1
c. Social Well-Being			6	5	4	3	1
d. Regional Development			6	5	4	3	1
IV. IMPLEMENTATION RESPONSIBILITY							
1. First Cost							
a. Federal			$40,400,000	$39,500,000	$40,400,000	$35,700,000	$33,200,000
b. Non-Federal			13,500,000	13,200,000	13,500,000	11,900,000	11,000,000
c. Total			53,900,000	52,700,000	53,900,000	47,600,000	44,200,000
2. Annual Cost							
a. Federal			3,600,000	3,510,000	3,590,000	3,170,000	2,950,000
b. Non-Federal			1,720,000	1,700,000	1,730,000	1,530,000	[illegible]
c. Total			5,320,000	5,210,000	5,320,000	4,700,000	4,400,000

Index of footnotes:

Timing

1. Impact is expected to occur prior to or during implementation of the plan. 2. Impact is expected within 15 years following plan implementation. 3. Impact is expected in a longer time frame(15 or more years following implementation).

Uncertainty

4. The uncertainty associated with the impact is 50% or more. 5. The uncertainty is between 10% and 50%. 6. The uncertainty is less than 10%.

Exclusivity

7. Overlapping entry, fully monetized in NED account. 8. Overlapping entry; not fully monetized in NED account.

Actuality

9. Impact will occur with implementation. 10. Impact will occur only when specific additional actions are carried out during implementation. 11. Impact will not occur because necessary additional actions are lacking.

Section 122

*. Items specifically required in Section 122 and ER 1105-2-240.

1/ Based on October 1982 price levels and amortization over 50 years at 7 7/8% interest.
2/ All plans include a 3 sq mi delta formed in Big Mar.

Item	Existing Condition	Future Condition No Action	Plan 6	Plan 7	Plan 8	Plan 9	Plan 10
I. PLAN DESCRIPTION			Big Mar = [illegible] CFS Oakville = 5,025 CFS Bayou Fortiere = [illegible] CFS	Big Mar = [illegible] CFS Oakville = 5,[illegible] CFS Bayou Lasseigne=5,025 CFS	Big Mar = 6,[illegible] CFS Oakville = 3,55[illegible] CFS Bayou Fortiere=7,1[illegible] CFS	Big Mar = 6,600 CFS Oakville = 3,550 CFS Bayou Lasseigne=7,1[illegible] CFS	Big Mar= 6,[illegible] CFS Oakville= 3,550 CFS Bayou Fortiere 3,[illegible] CFS Bayou Lasseigne = 3,550 CFS
II. SIGNIFICANT IMPACTS							
1. National Economic Development (NED)							
a. Total average annual benefits			$15,760,000	$15,76[illegible],000	$15,76[illegible]	$15,760,000	$15,760,[illegible]
b. Total average annual costs			4,680,000	4,5[illegible]0,000	4,7[illegible]0,000	4,6[illegible],000	5,[illegible]
(1) Interest and amortization			4,176,000	4,026,000	4,236,000	4,[illegible]	4,[illegible]
(2) Operation and maintenance			504,000	504,000	502,000	5[illegible]2,000	[illegible]
c. First Cost			$47,[illegible]	$46,300,000	$47,[illegible]	$46,[illegible]	$53,[illegible]
d. Net annual NED benefits			11,080,000	11,230,000	11,0[illegible],000	[illegible]	[illegible]
e. Benefit-Cost ratio			3.[illegible]	3.5	3.3	[illegible]	[illegible]
2. Environmental Quality (EQ)							
a. Wetlands	881,100 acres of wetlands 657,400 acres of marsh	486,100 acres of wetlands (376,500 acres of marsh).	591 acres altered, 99,162 acres marsh saved. (1,2,3,5)	Similar to plan 6.	Similar to plan 6.	Similar to plan 6.	Similar to plan 6.
b. Water Bodies	982,000 acres of canals, lakes, bays, & sound.	1,262,900 acres of water.	266 ac altered. 3.5 sq mi delta formed. (1,2,3,5,9)	Similar to plan 6.	Similar to plan 6. 4 sq mi delta formed.	Similar to plan 6.	Similar to plan 6.
c. Water Quality*	Fresh to saline, warm. Trace metals nutrients, fecal coliform bacteria occasionally exceeded criteria.	Water quality degraded. 15 ppt isohaline 12 miles north in Barataria Bay, 17 miles in Breton Sound.	Divert into fresh brackish waters. Cool, increased turbidity, possible bioaccumulation of pollutants, fecal coliform bacteria. (1,2,3,5,9)	Same as plan 6.	Same as plan 6.	Same as plan 6.	Same as plan 6.
d. Prime and unique farmland* and other lands.	Sugarcane land. Other includes disposal & developed areas.	Farmland converted to other uses in nearby urbanizing areas.	60 acres of farmland & 43 acres of others. (1,2,3,5,9)	Similar to plan 6.	Similar to plan 6.	Similar to plan 6.	Similar to plan 6.
e. Endangered species	Bald eagle & brown pelican nest in area; Arctic peregrine falcon visitor.	Species adversely affected by habitat deterioration.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
f. Fish and Wildlife	$115,000,000 total income.	$66,000,000 total income.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
g. National Register of Historic Places	None	None	None	None	None	None	None
3. Social Well-Being							
a. Community cohesion*	Unique cultural heritage lifestyles dependent on fishing & trapping.	Preservation of lifestyles & community cohesion difficult.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
b. Community growth*	Dependent on the fish & wildlife industries.	Population & opportunities would decline.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.

[illegible]

[illegible]

[illegible]

Item	Existing Condition 1980	Future Condition (No Action) 2035	Plan 6	Plan 7	Plan 8	Plan 9	Plan 10
c. Displacement of People* Businesses			None Relocate 3 businesses (1,2,3,5,9)	None Same as plan 6.	None Same as plan 6.	None Same as plan 6.	None Same as plan 6.
d. Leisure*	1,065,000 man-days of sport fishing & hunting.	869,000 man-days of sport fishing & hunting.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
e. Property values*		Continued decline.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
f. Tax Revenues*		Taxes derived from fish & & wildlife activities would decline.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
g. Transportation*			Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
h. Noise*			Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
i. Quality of community life			Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
4. Regional Development (RD)							
a. Employment and income		Continued decline in employment, & income in fish & wildlife related industries.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
b. Regional growth and businesses activity		Continued decline in activities related to fish and wildlife.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
III. Plan Evaluation							
1. Contribution to Planning Objectives							
a. Increase fish and wildlife production (NED)			Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
b. Preserve and restore wetlands, enhance vegetative growth, establish favorable salinity gradients, improve sport fish and wildlife opportunities (EQ)			Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
2. Net Effects							
a. Net NED average annual benefits			$11,080,000	$11,230,000	$11,020,000	$11,160,000	$10,480,000
b. Net EQ effects			Moderately positive	Moderately positive	Moderately positive	Moderately positive	Moderately positive
c. Net Social Well-Being Effects			Slightly positive	Slightly positive	Slightly positive	Slightly positive	Slightly positive
d. Net Regional Development Effects			Slightly positive	Slightly positive	Slightly positive	Slightly positive	Slightly positive

Item	Existing Condition 1980	Future Condition (No Action) 2035	Plan 6	Plan 7	Plan 8	Plan 9	Plan 10
3. Plan Response to Associated Evaluation Criteria							
a. Acceptability			Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.	Same as plan 1.
b. Efficiency			Less efficient than plans 1-5, & 16 same as 7-9, more than 10-15.	Same as plan 6.	Same as plan 6.	Same as plan 6.	Less efficient than plans 1-9 & 11 -14, & 16 same as plan 15.
c. Geographic scope			Maintains desired conditions in [illegible] smaller area.	Same as plan 6.	Same as plan 6.	Same as plan 6.	Same as plan 6.
d. NED benefit-cost ratio			3.4	3.5	3.3	3.4	3.0
e. Reversability			Less reversible than 4, 5, 16. Same as 1-3, 7-9, 11-14, more than 10 & 15.	Same as plan 6.	Same as plan 6.	Same as plan 6.	Least reversible.
4. Rankings of plans a. NED Objectives			5	2	8	3	13
b. EQ objectives			11	10	8	7	9
c. Social Well-Being			11	10	8	7	9
d. Regional Development			11	10	8	7	9
IV. IMPLEMENTATION RESPONSIBILITY							
1. First Cost a. Federal			$35,200,000	$34,000,000	$35,800,000	$34,600,000	$39,900,000
b. Non-Federal			11,800,000	11,300,000	11,900,000	11,500,000	13,200,000
c. Total			47,000,000	45,300,000	47,700,000	46,100,000	53,100,000
2. Annual Cost a. Federal			3,130,000	3,020,000	3,180,000	3,070,000	3,550,000
b. Non-Federal			1,550,000	1,510,000	1,560,000	1,530,000	1,730,000
c. Total			4,680,000	4,530,000	4,740,000	4,600,000	5,280,000

Index of footnotes:

Timing

1. Impact is expected to occur prior to or during implementation of the plan. 2. Impact is expected within 15 years following plan implementation. 3. Impact is expected in a longer time frame(15 or more years following implementation)

Uncertainty

4. The uncertainty associated with the impact is 50% or more. 5. The uncertainty is between 10% and 50%. 6. The uncertainty is less than 10%.

Exclusivity

7. Overlapping entry; fully monetized in NED account. 8. Overlapping entry; not fully monetized in NED account.

Actuality

9. Impact will occur with implementation. 10. Impact will occur only when specific additional actions are carried out during implementation. 11. Impact will not occur because necessary additional actions are lacking.

Section 122

*. Items specifically required in Section 122 and ER 1105-2-240.

1/ Based on October 1982 price levels and amortization over 50 years at 7 7/8% interest.

2/ All plans include a 3 sq mi delta formed in Big Mar.

TABLE B-2-?

SUMMARY PRESENTATION AND ASSESSMENT OF DETAILED PLANS

Plans 11-13

Item	Existing Condition 1980	Future Conditions (No Action) 2035	Plan 11	Plan 12	Plan 13
I. PLAN DESCRIPTION			Big Mar - 6,600 CFS Myrtle Grove - 5,325 CFS Bayou Fortier-5,325 CFS	Big Mar - 6,600 CFS Myrtle Grove - 5,325 CFS Bayou Lasseigne-5,325 CFS	Big Mar - 6,600 CFS Myrtle Grove - 3,550 CFS Bayou Foriter-7,100 CFS
II. SIGNIFICANT IMPACTS 1/					
1. National Economic Development (NED)					
a. Total average annual benefits			$15,760,000	$15,760,000	$15,760,000
b. Total average annual costs			4,810,000	4,650,000	4,870,000
(1) Interest and amortization			4,306,000	4,146,000	4,368,000
(2) Operation and maintenance			504,000	504,000	502,000
c. First Cost			$48,400,000	$46,700,000	$49,100,000
d. Net annual NED benefits			10,950,000	11,110,000	10,890,000
e. Benefit-Cost ratio			3.3	3.4	3.2
2. Environmental Quality (EQ) a. Wetlands	881,100 acres of wetlands (657,400 acres of marsh).	488,100 acres of wetlands (376,500 acres of marsh).	662 acres altered. 90,162 acres marsh saved. (1,2,3,5,9)	Similar to plan 11.	Similar to plan 11.
b. Water bodies 2/	982,000 acres of canals, lakes, bays, & sound.	1,262,900 acres of water.	391 ac altered. 3.5 sq mi delta formed. (1,2,3,5,9)	Similar to plan 11.	Similar to plan 11. 4 sq mi delta formed.
c. Water Quality*	Fresh to saline warm. Trace metals, nutrients, fecal coliform bacteria occasionally exceed criteria.	Water quality degraded. 15 ppt isohaline 12 miles north in Barataria Bay, 17 miles in Breton Sound.	Divert into fresh/saline waters. Cool, increased turbidity, possible bio-accumulation of pollutants, & fecal coliform bacteria. (1,2,3,5,9)	Same as plan 11.	Same as plan 11.
d. Prime and unique farmland* and other lands.	Sugarcane land. Other includes disposal & developed areas.	Farmland converted to other uses near urban areas.	84 acres of farmland, 56 acres of other. (1,2,3,5,9)	Similar to plan 11.	Similar to plan 11.
e. Endangered species	Bald eagle & brown pelican nest in area. Arctic peregrine falcon visitor.	Species adversely affected by habitat deterioration.	Same as plan 1.	Same as plan 1.	Same as plan 1.
f. Fish and Wildlife	$115,000,000 total income.	$66,000,000 total income.	Same as plan 1.	Same as plan 1.	Same as plan 1.
g. National Register of Historic Places	None	None	None	None	None
3. Social Well-Being a. Community Cohesion*	Unique cultural heritage & lifestyles dependent on fishing & trapping.	Preservation of lifestyles & community cohesion difficult.	Same as plan 1.	Same as plan 1.	Same as plan 1.
b. Community growth*	Dependent on fish & wildlife industries.	Population opportunities would decline.	Same as plan 1.	Same as plan 1.	Same as plan 1.

Item	Existing Condition 1980	Future Condition (No Action) [illegible]	Plan [illegible]	Plan [illegible]	Plan [illegible]
c. Displacement of People* Businesses			[illegible] None	Same as plan 11. None	Same as plan 11. None
d. Leisure*	1,065,000 man-days of sport fishing & hunting.	9[illegible]9,000 man-days of sport fishing & hunting.	Same as plan 1.	Same as plan 1.	Same as plan 1.
e. Property values*		Continued decline.	Same as plan 1.	Same as plan 1.	Same as plan 1.
f. Tax Revenues*		Taxes derived from fish wildlife activities would decline.	Same as plan 1.	Same as plan 1.	Same as plan 1.
g. Transportation*			Same as plan 1.	Same as plan 1.	Same as plan 1.
h. Noise*			Same as plan 1.	Same as plan 1.	Same as plan 1.
i. Quality of community life			Same as plan 1.	Same as plan 1.	Same as plan 1.
4. Regional Development (RD)					
a. Employment and income		Continued decline in employment, income in fish & wildlife related industries.	Same as plan 1.	Same as plan 1.	Same as plan 1.
b. Regional growth and businesses activity		Continued decline in activities related to fish & wildlife.	Same as plan 1.	Same as plan 1.	Same as plan 1.
III. Plan Evaluation 1. Contribution to Planning Objectives					
a. Increase fish and wildlife production (NED)			Same as plan 1.	Same as plan 1.	Same as plan 1.
b. Preserve and restore wetlands, enhance vegetative growth, establish favorable salinity gradients, improve sport fishing and wildlife opportunities.			Similar to plan 1.	Similar to plan 1.	Similar to plan 1.
2. Net Effects					
a. Net NED average annual benefits.			$10,950,000	$11,110,000	$10,890,000
b. Net EQ effects.			Slightly positive	Slightly positive	Slightly positive
c. Net Social Well-Being Effects			Slightly positive	Slightly positive	Slightly positive
d. Net Regional Development Effects			Slightly positive	Slightly positive	Slightly positive
3. Plan Response to Associated Evaluation Criteria					
a. Acceptability			Same as plan 1.	Same as plan 1.	Same as plan 1.
b. Efficiency			Less efficient than plans 1-5, 16, same as 7-9, 12-14, more than 10 & 15.	Same as plan 11.	Same as plan 11.
c. Geographic scope			Maintains desired conditions in a smaller area.	Same as plan 11.	Same as plan 11.
d. NED benefit-cost ratio			3.4	3.4	3.2
e. Reversability			Same as plan 6.	Same as plan 6.	Same as plan 6.
4. Rankings of plans					
a. NED Objectives			10	4	11
b. EQ objectives			16	15	13
c. Social Well-Being			16	15	13
d. Regional Development			16	15	13

TABLE H-2-6 (CONTINUED)

SUMMARY PRESENTATION AND ASSESSMENT OF DETAILED PLANS

Plans 11-13

Item	Existing Condition 1980	Future Condition (No Action) 2035	Plan 11	Plan 12	Plan 13
IV. IMPLEMENTATION RESPONSIBILITY					
1. First Cost					
a. Federal			$36,300,000	$35,000,000	$36,800,000
b. Non-Federal			12,100,000	11,700,000	12,300,000
c. Total			48,400,000	46,700,000	49,100,000
2. Annual Cost					
a. Federal			3,230,000	3,110,000	3,280,000
b. Non-Federal			1,580,000	1,540,000	1,590,000
c. Total			4,810,000	4,650,000	4,870,000

Index of footnotes:

Timing:
1. Impact is expected to occur prior to or during implementation of the plan. 2. Impact is expected within 15 years following plan implementation. 3. Impact is expected in a longer time frame(15 or more years following implementation).

Uncertainty

4. The uncertainty associated with the impact is 50% or more. 5. The uncertainty is between 10% and 50%. 6. The uncertainty is less than 10%.

Exclusivity

7. Overlapping entry; fully monetized in NED account. 8. Overlapping entry; not fully monetized in NED account.

Actuality

9. Impact will occur with implementation. 10. Impact will occur only when specific additional actions are carried out during implementation. 11. Impact will not occur because necessary additional actions are lacking.

Section 122

*. Items specifically required in Section 122 and ER 1105-2-240.

1/ Based on October 1982 price levels and amortization over 50 years at 7 7/8 % interest.

2/ All plans include a 3 sq mi delta formed in Big Mar.

TABLE H-1-4 (CONTINUED)

SUMMARY PRESENTATION AND ASSESSMENT OF DETAILED PLANS

Plans 14-16

Item	Existing Condition 1980	Future Conditions (No Action) 2035	Plan 14	Plan 15	Plan 16
I. PLAN DESCRIPTION			Big Mar - 6,600 CFS Myrtle Grove - 3,550 CFS Bayou Fortier-7,100 CFS	Big Mar - 6,600 CFS Myrtle Grove - 3,550 CFS Bayou Fortier- 3,550 CFS Bayou Lasseigne-3,550 CFS	Big Mar - 6,600 CFS Davis Pond - 10,650 CFS
II. SIGNIFICANT IMPACTS					
1. National Economic Development (NED) 1/					
a. Total average annual benefits			$15,760,000	$15,760,000	$15,760,000
b. Total average annual costs			4,720,000	5,400,000	4,760,000
(1) Interest and amortization			4,219,000	4,747,000	4,215,000
(2) Operation and maintenance			502,000	553,000	545,000
c. First Cost			$47,500,000	$54,500,000	$47,400,000
d. Net annual NED benefits			11,040,000	10,360,000	11,000,000
e. Benefit-Cost ratio			3.3	2.9	3.3
2. Environmental Quality (EQ) a. Wetlands	881,100 acres of wetlands (657,400 acres of marsh).	488,100 acres of wetlands. (376,500 acres of marsh).	Similar to plan 11.	Similar to plan 11.	305 acres altered, 99,162 marsh saved. (1,2,3,5,9)
b. Water bodies 2/	982,000 acres of canals, lakes, bays, & sound.	1,262,900 acres of water.	Similar to plan 13.	Similar to plan 13.	218 acres of water altered. 6 sq mi delta formed.(1,2,3,5,9) (1,2,3,5)
c. Water Quality*	Fresh to saline, warm. Trace metals, nutrients, fecal coliform bacteria occasionally exceed criteria.	Water quality degraded. 15 ppt isohaline 12 miles north in Barataria Bay, 17 miles in Breton Sound.	Same as plan 11.	Same as plan 11.	Direct in fresh lake. Cool, increased turbidity, possible bioaccumulation of pollutants, fecal coliform bacteria. (1,2,3,5,9)
d. Prime and unique farmland* and other lands.	Sugarcane land. Other includes disposal & developed areas.	Farmland converted to other uses near urban areas.	Similar to plan 11.	Similar to plan 11.	36 acres of farmland, 4 acres of other. (1,2,3,5,9)
e. Endangered species	Bald eagle & brown pelican nest in area, Arctic peregrine falcon visitor.	Species adversely affected by habitat deterioration.	Same as plan 1.	Same as plan 1.	Same as plan 1.
f. Fish and Wildlife	$115,000,000 total income.	$66,000,000 total income.	Same as plan 1.	Same as plan 1.	Same as plan 1.
g. National Register of Historic Places	None	None	None	None	None
3. Social Well-Being a. Community Cohesion*	Unique cultural heritage & lifestyles dependent on fishing & trapping.	Preservation of lifestyles & community cohesion difficult.	Same as plan 1.	Same as plan 1.	Same as plan 1.
b. Community growth*	Dependent on fish & wildlife industries.	Population opportunities decline.	Same as plan 1.	Same as plan 1.	Same as plan 1.

Item	Existing condition 196[illegible]	Future condition [illegible]	[illegible]	[illegible]	[illegible]
c. Displacement of People* Businesses			[illegible]	[illegible]	None Same as plan 1.
d. Leisure*	1,65,000 man-days of sport fishing & hunting.	[illegible] man-days of sport fishing & hunting.	[illegible]	[illegible] plan 1.	Same as plan 1.
e. Property Values*		Continued decline.	Same as plan 1.	Same as plan 1.	Same as plan 1.
f. Tax Revenues*		Taxes derived from fish & wildlife activities would decline.	Same as plan 1.	Same as plan 1.	Same as plan 1.
g. Transportation*			Same as plan 1.	Same as plan 1.	Same as plan 1.
h. Noise*			Same as plan 1.	Same as plan 1.	Same as plan 1.
i. Quality of community life			Same as plan 1.	Same as plan 1.	Same as plan 1.
4. Regional Development (RD)					
a. Employment and income		Continued decline in employment, income in fish & wildlife related industries.	Same as plan 1.	Same as plan 1.	Same as plan 1.
b. Regional growth and businesses activity		Continued decline in activities related to fish & wildlife.	Same as plan 1.	Same as plan 1.	Same as plan 1.
III. Plan Evaluation					
1. Contribution to Planning Objectives					
a. Increase fish and wildlife production (NED)			Same as plan 1.	Same as plan 1.	Same as plan 1.
b. Preserve and restore wetlands, enhance vegetative growth, establish favorable salinity gradients, improve sport fishing and wildlife opportunities.			Similar to plan 1.	Similar to plan 1.	Similar to plan 1.
2. Net Effects					
a. Net NED average annual benefits.			$11,[illegible]0,000	$10,360,000	$11,000,000
b. Net EQ effects.			Slightly positive	Slightly positive	Moderately positive
c. Net Social Well-Being Effects			Slightly positive	Slightly positive	Slightly positive
d. Net Regional Development Effects			Slightly positive	Slightly positive	Slightly positive
3. Plan Response to Associated Evaluation Criteria					
a. Acceptability			Same as plan 1.	Same as plan 1.	Local interests support plan.
b. Efficiency			Same as plan 11.	Least efficient.	More efficient than plans 1-3, same as plans 4,2,5, more efficient than plans 6-15.
c. Geographic scope			Same as plan 11.	Same as plan 11.	Same as plan 6.
d. NED benefit-cost ratio			3.3	2.9	3.3
e. Reversability			Same as plan 6.	Same as plan 10.	
4. Rankings of plans					
a. NED Objectives			7	16	9
b. EQ objectives			12	14	2
c. Social Well-Being			12	14	2
d. Regional Development			12	14	2

TABLE B-24A (CONTINUED)

SUMMARY COMPARISON AND ASSESSMENT OF ALTERNATIVE PLANS

Plans 14-16

Item	Existing Condition 1980	Future Condition (No Action) 2035	Plan 14	Plan 15	Plan 16
IV. IMPLEMENTATION RESPONSIBILITY					
1. First Cost					
a. Federal			$35,600,000	$40,900,000	$35,600,000
b. Non-Federal			11,900,000	13,600,000	11,800,000
c. Total			47,500,000	54,500,000	47,400,000
2. Annual Cost					
a. Federal			3,160,000	3,640,000	3,160,000
b. Non-Federal			1,560,000	1,760,000	1,600,000
c. Total			4,720,000	5,400,000	4,760,000

Index of footnotes:

__Timing__:
1. Impact is expected to occur prior to or during implementation of the plan. 2. Impact is expected within 15 years following plan implementation. 3. Impact is expected in a longer time frame(15 or more years following implementation).

__Uncertainty__

4. The uncertainty associated with the impact is 50% or more. 5. The uncertainty is between 10% and 50%. 6. The uncertainty is less than 10%.

__Exclusivity__

7. Overlapping entry; fully monetized in NED account. 8. Overlapping entry; not fully monetized in NED account.

__Actuality__

9. Impact will occur with implementation. 10. Impact will occur only when specific additional actions are carried out during implementation. 11. Impact will not occur because necessary additional actions are lacking.

__Section 122__

*. Items specifically required in Section 122 and ER 1105-2-240.

1/ Based on October 1982 price levels and amortization over 50 years at 7 7/8 % interest.

2 All plans include a 3 sq mi delta formed in Big Mar.

DIVISION OF RESPONSIBILITY

B.2.11. For all plans, the division of plan responsibilities would be the same. Before construction of the facilities by the Federal Government, non-Federal interests must agree to comply with the following requirements:

- Provide, without cost to the United States, all lands, easements, and rights-of-way necessary for construction and operation of the works;

- Hold and save the United States free from damages due to the construction works except where such damages are due to the fault or negligence of the United States or its contractors;

- Operate and maintain the works after completion;

- Contribute 25 percent of the project construction cost; and

- Assure adequate public access to the project.

In addition, the non-Federal sponsor(s) must agree to comply with the following:

- Section 221, Public Law 91-611, approved 31 December 1970, as amended;

- Section 601 of Title VI of the Civil Rights Act of 1964 (Public Law 88-352) that no person shall be excluded from participation in, denied the benefits of, or subjected to discrimination in connection with the project on the grounds of race, creed, or national origin; and

- the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646.

B.2.47. The first cost of Plan 11 is estimated at $48,400,000. The ratio of average annual benefits to average annual cost is 3.3. Average annual benefits in excess of costs are estimated at $10,950,000.

B.2.48. Construction impacts include converting 141 acres of bottomland hardwoods, 227 acres of wooded swamp, 74 acres of fresh marsh, 16 acres of intermediate marsh, 211 acres of brackish marsh, and 84 acres of agricultural lands to lower value habitat. The land conversion would result in the loss of 598 man-days of hunting. This loss would be offset by the substantial reduction in projected loss of recreational opportunities attributed to the plan. Water quality in the receiving areas would be generally degraded. Specific water quality impacts include alteration of the existing hydraulic regime and sedimentation patterns, and accelerated aging of Big Mar and Lac Des Allemands. The diverted flow could raise the level of Lac Des Allemands about 0.6 inches under adverse conditions. Diverting a portion of the flow at the Myrtle Grove site would increase concentrations of pollutants and coliform bacteria and decrease water temperatures in Bartaria Bay. A high probability exists of affecting cultural remains in the Myrtle Grove rights-of-way. Increased flow in Bayou Barataria and Bayou Des Allemands could have erosive impacts on archeological sites along the bayous.

PLAN 12

- o Three salinity control structures with appurtenant channels, one on the east bank and two on the west bank of the Mississippi River.

- o 6,600 cfs design capacity at Big Mar on the east bank.

- o 5,325 cfs design capacity at Myrtle Grove on the west bank.

45. Construction impacts include converting 114 acres of bottomland woods, 444 acres of wooded swamp, 203 acres of fresh marsh, 16 acres ntermediate marsh, and 107 acres of agricultural lands to lower e habitat. An estimated loss of 761 man-days of hunting would r. This loss would be offset by the substantial reduction in ected loss of recreational opportunities attributed to the plan. r quality in the receiving areas would be generally degraded. ific water quality impacts include alteration of the existing aulic regime and sedimentation patterns, and accelerated aging of Mar and Lac Des Allemands. The diverted flow could raise the level ac Des Allemands about 0.8 inches under adverse conditions. rting a portion of the flow at the Oakville site would increase entrations of pollutants and coliform bacteria and decrease water eratures in Barataria Bay. A high probability exists of affecting ural resources in the Oakville rights-of-way. Increased flows in u Barataria and Lac Des Allemands could have erosive impacts on eological sites along the bayous.

1 11

o Three salinity control structures with appurtenant channels, one he east bank and two on the west bank of the Mississippi River.

o 6,600 cfs design capacity at Big Mar on the east bank.

o 5,325 cfs design capacity at Myrtle Grove on the west bank.

o 5,325 cfs design capacity at Bayou Fortier site on the west .

46. Plan 11 would require 1,200 acres for construction and itenance, relocation of five roads, three railroads, and six lines, and maintenance dredging estimated at 46,100 cubic yards in average year.

impacts include alteration of the existing hydraulic regime and sedimentation patterns, and accelerated aging of Big Mar and Lac Des Allemands. The diverted flow could raise the level of Lac Des Allemands about 0.8 inches under adverse conditions. Diverting a portion of the flow at the Oakville site would increase concentrations of pollutants and coliform bacteria and decrease water temperatures in Barataria Bay. A high probability exists of affecting cultural remains in the Oakville site rights-of-way. Increased flow in Bayou Barataria and Bayou Des Allemands could have erosive impacts on archeological sites along the bayous.

PLAN 10

o Four salinity control structures with appurtenant channels, one on the east bank and three on the west bank of the Mississippi River.

o 6,600 cfs design capacity at Big Mar site on the east bank.

o 3,550 cfs design capacity at the Oakville site on the west bank.

o 3,500 cfs design capacity at the Bayou Fortier site on the west bank.

o 3,550 cfs design capacity at the Bayou Lasseigne site on the west bank.

B.2.43. The plan would require 1,176 acres for construction and maintenance, relocation of seven roads, four railroads, and eight pipelines, and maintenance dredging estimated at 46,500 cubic yards in an average year.

B.2.44. The first cost of Plan 10 is estimated to be $53,100,000. The benefit-to-cost ratio is 3.0. Average annual benefits in excess of costs are estimated at $10,480,000.

of pollutants and coliform bacteria and decrease water temperatures in Barataria Bay. A high probability exists of affecting cultural remains in the Oakville and Bayou Fortier sites rights-of-way. Increased flow in Bayou Barataria and Bayou Des Allemands could have erosive impacts on archeological sites along the bayou.

PLAN 9

o Three salinity control structures with appurtenant channels, one on the east bank and two on the west bank of the Mississippi River.

o 6,600 cfs design capacity at the Big Mar site on the east bank.

o 7,100 cfs design capacity at the Bayou Lasseigne site on the west bank.

o 3,550 cfs design capacity at the Oakville site on the west bank.

B.2.40. The plan would require 904 acres for construction and maintenance, relocation of four roads, three railroads, and six pipelines, and maintenance dredging estimated at 46,400 cubic yards in an average year.

B.2.41. The estimated first cost of Plan 9 is $46,100,000. The benefit-to-cost ratio is 3.4. Average annual benefits over costs are estimated to be $11,160,000.

B.2.42. Construction impacts include converting 31 acres of bottomland hardwoods, 383 acres of wooded swamp, 212 acres of fresh marsh, 16 acres of intermediate marsh, and 71 acres of agricultural lands to lower value habitat. An estimated 624 man-days of hunting loss would occur. The loss would be offset by the substantial reduction in projected loss of recreational opportunities attributed to the plan. Water quality in the receiving areas would be generally degraded. Specific water quality

PLAN 8

- o Three salinity control structures with appurtenant channels, one on the east bank and two on the west bank of the Mississippi River.

- o 6,600 cfs design capacity at the Big Mar site on the east bank.

- o 7,100 cfs design capacity at the Bayou Fortier site on the west bank.

- o 3,500 cfs design capacity at the Oakville site on the west bank.

B.2.37. The plan would require 961 acres for construction and maintenance, relocation of five roads, three railroads, and six pipelines, and maintenance dredging estimated at 46,400 cubic yards in an average year.

B.2.38. The estimated first cost of Plan 8 is $47,700,000. The benefit-to-cost ratio is 3.3. Average annual benefits over the costs are estimated to be $11,020,000.

B.2.39. Construction impacts include converting 142 acres of bottomland hardwoods, 291 acres of wooded swamp, 147 acres of fresh marsh, 16 acres of intermediate marsh, and 66 acres of agricultural lands to lower value habitat. An estimated 583 man-days of hunting loss would occur. The loss would be offset by the substantial reduction in projected loss of recreational opportunities attributed to the plan. Water quality in the receiving areas would be generally degraded. Specific water quality impacts include alteration of the existing hydraulic regime and sedimentation patterns, and accelerated aging of Big Mar and Lac Des Allemands. The diverted water would raise the level of the Lac Des Allemands about 0.8 inches under adverse conditions. Diverting a portion of the flow at the Oakville site would increase concentrations

B.2.34. The plan would require 886 acres for construction and maintenance, relocation of four roads, three railroads, and six pipelines, and maintenance dredging estimated at 46,100 cubic yards in an average year.

B.2.35. The estimated first cost of Plan 7 is $45,300,000. The benefit-to-cost ratio is 3.5. Average annual benefits over costs are estimated to be $11,230,000.

B.2.36. Construction impacts include converting 35 acres of bottomland hardwoods, 350 acres of wooded swamp, 217 acres of fresh marsh, 16 acres of intermediate marsh, and 63 acres of agricultural lands to lower value habitat. An estimated 598 man-days of hunting loss would occur. The loss would be offset by the substantial reduction in projected loss of recreational opportunities attributed to the plan. Water quality in the receiving areas would be generally degraded. Specific water quality impacts include alteration of the existing hydraulic regime and sedimentation patterns, and accelerated aging of Big Mar and Lac Des Allemands. The diverted water could raise the level of the Lac Des Allemands about 0.6 inches under adverse conditions. Diverting a portion of the flow at the Oakville site would increase concentrations of pollutants and coliform bacteria and decrease water temperatures in Barataria Bay. A high probability exists of affecting cultural remains in the Oakville site rights-of-way. Increased flow in Bayou Barataria and Bayou Des Allemands could have erosive impacts on archeological sites along the bayous.

B.2.32. The estimated first cost of Plan 6 is $47,000,000. The benefit-to-cost ratio is 3.4. Average annual benefits over the costs are estimated to be $11,080,000.

B.2.33. Construction impacts include converting 134 acres of bottomland hardwoods, 282 acres of wooded swamp, 159 acres of fresh marsh, 16 acres of intermediate marsh, and 60 acres of agricultural lands to lower value habitat. An estimated 578 man-days of hunting loss would occur. This loss would be offset by the substantial reduction in projected loss of recreational opportunities attributed to the plan. Water quality in the receiving area would be generally degraded. Specific water quality impacts include alteration of the existing hydraulic regime and sedimentation patterns, and accelerated aging of Big Mar and Lac Des Allemands. Diverting a portion of the flow at the Oakville site would increase concentrations of pollutants and coliform bacteria and decrease water temperature in Barataria Bay. The diverted water could raise the level of Lac Des Allemands about 0.6 inches under adverse conditions. A high probability exists of affecting cultural remains in the Oakville and Bayou Fortier sites rights-of-way. Increased flow in Bayou Barataria and Bayou Des Allemands would have erosive impacts on archeological sites along the bayous.

PLAN 7

o Three salinity control structures with appurtenant channels, one on the east bank and two on the west bank of the Mississippi River.

o 6,600 cfs design capacity at the Big Mar site on the east bank.

o 5,325 cfs design capacity at the Bayou Lasseigne site on the west bank.

o 5,325 cfs design capacity at the Oakville site on the west bank.

B.2.30. Construction impacts include converting 22 acres of bottomland hardwoods, 395 acres of wooded swamp, 177 acres of fresh marsh, 16 acres of intermediate marsh, and 85 acres of agricultural lands to lower value habitat. These conversions would result in an estimated loss of 597 man-days of hunting. This loss would be offset by the substantial reduction in projected loss of recreational opportunities attributable to the plan. Water quality in the receiving areas would be generally degraded. Specific water quality impacts include alteration of the existing hydraulic regime and sedimentation patterns, and accelerated aging of Big Mar and Lac Des Allemands. The diverted water could raise the level of Lac Des Allemands about 2.5 inches under adverse conditions. A low probability exists of affecting cultural remains in the rights-of-way, but increased flow in Bayou Des Allemands could have erosive impacts on archeological sites along the bayou.

PLAN 6

- Three salinity control structures with appurtenant channels, one on the east bank and two on the west bank of the Mississippi River.

- 6,660 cfs design capacity at the Big Mar site on the east bank.

- 5,325 cfs design capacity at the Bayou Fortier site on the west bank.

- 5,325 cfs design capacity at the Oakville site on the west bank.

B.2.31. The plan would require 960 acres for construction and maintenance, relocation of five roads, three railroads, and six pipelines, and maintenance dredging estimated at 46,100 cubic yards in an average year.

B.2.27. Construction impacts include converting 161 acres of bottomland hardwoods, 318 acres of wooded swamp, 130 acres of fresh marsh, 16 acres of intermediate marsh, and 82 acres of agricultural lands to lower value habitat. An estimated loss of 615 man-days of hunting would occur. This loss would be offset by the substantial reduction in projected loss of recreational opportunities attributable to the plan. Water quality in the receiving areas would be generally degraded. Specific water quality impacts include alteration of the existing hydraulic regime and sedimentation patterns, and accelerated aging of Big Mar and Lac Des Allemands. The diverted water could raise the level of Lac Des Allemands about 2.5 inches under adverse conditions. A high probability exists of affecting cultural remains in the Bayou Fortier site rights-of-way, and increased flow in Bayou Des Allemands could have erosive impacts on archeological sites along the bayou.

PLAN 5

- Two salinity control structures with appurtenant channels, one on the east bank and one on the west bank of the Mississippi River.

- 6,600 cfs design capacity at the Big Mar site on the east bank.

- 10,650 cfs design capacity at the Bayou Lasseigne site on the west bank.

B.2.28. Plan implementation requires a total of 778 acres of construction and maintenance, relocation of three roads, two railroads, and five pipelines, and maintenance dredging estimated at 47,100 cubic yards in an average year.

B.2.29. The estimated first cost of Plan 5 is $44,200,000. The ratio of average annual benefits to average annual cost is 3.6. Average annual benefits in excess of costs are $11,360,000.

B.2.24. Construction impacts include converting 121 acres of bottomland hardwoods, 516 acres of wooded swamp, 206 acres of fresh marsh, and 123 acres of agricultural lands to lower value habitat. An estimated loss of 845 man-days of hunting would occur. This loss would be offset by the substantial reduction in projected loss of recreational opportunities attributable to the plan. Water quality in the receiving areas would be generally degraded. Specific water quality impacts include alteration of the existing hydraulic regime and sedimentation patterns, and accelerated aging of Big Mar and Lac Des Allemands. The diverted water could raise the level of Lac Des Allemands about 2.5 inches under adverse conditions. A high probability exists of affecting cultural remains in the Bayou Fortier site rights-of-way, and increased flow could have erosive impacts on archeological sites along Bayou Des Allemands.

PLAN 4

o Two salinity control structures with appurtenant channels, one on the east bank and one on the west bank of the Mississippi River.

o 6,600 cfs design capacity at the Big Mar site on the east bank.

o 10,650 cfs design capacity at the Bayou Fortier site on the west bank.

B.2.25. Plan implementation requires a total of 905 acres for construction and maintenance, relocation of four roads, two railroads, and five pipelines, and maintenance dredging estimated at 47,100 cubic yards in an average year.

B.2.26. The estimated first cost of Plan 4 is $47,600,000. The ratio of average annual benefits to average annual cost is 3.4. Average annual benefits in excess of costs are $11,060,000.

attributable to the plan. Water quality in the receiving areas would be generally degraded. Specific water quality impacts include alteration of the existing hydraulic regime and sedimentation patterns, and accelerated aging of Big Mar and Lac Des Allemands. The diverted water could raise the level of Lac Des Allemands about 2.5 inches under adverse conditions. A high probability exists of affecting cultural remains in the Bayou Fortier site rights-of-way, and increased flow could have erosive impacts on archeological sites along Bayou Des Allemands.

PLAN 3

- Three salinity control structures with appurtenant channels, one on the east bank and two on the west bank of the Mississippi River.

- 6,600 cfs design capacity at the Big Mar site on the east bank.

- 5,325 cfs design capacity at the Bayou Fortier site on the west bank.

- 5,325 cfs design capacity at the Bayou Lasseigne site on the west bank.

B.2.22. Plan implementation requires a total of 1,169 acres for construction and maintenance, relocation of six roads, three railroads, and seven pipelines, and maintenance dredging estimated at 47,100 cubic yards in an average year.

B.2.23. The estimated first cost of Plan 3 is $53,900,000. The ratio of average annual benefits to average annual costs is 3.0. Average annual benefits in excess of costs are $10,440,000.

inches under adverse conditions. A high probability exists of affecting cultural remains in the Bayou Fortier site rights-of-way, and increased flow in Bayou Des Allemands could have erosive impacts on archeological sites along the bayou.

PLAN 2

- Three salinity control structures with appurtenant channels, one on the east bank and two on the west bank of the Mississippi River.

- 6,600 cfs design capacity at the Big Mar site on the east bank.

- 3,550 cfs design capacity at the Bayou Fortier site on the west bank.

- 7,100 cfs design capacity at the Bayou Lasseigne site on the west bank.

B.2.19. Plan implementation requires a total of 1,131 acres for construction and maintenance, relocation of six roads, three railroads, and seven pipelines, and maintenance dredging estimated at 47,100 cubic yards in an average year.

B.2.20. The first cost of Plan 2 is estimated to be $52,700,000. The ratio of average annual benefits to average annual costs is 3.0. Average annual benefits in excess of costs are estimated at $10,550,000.

B.2.21. Construction impacts include converting 105 acres of bottomland hardwoods, 511 acres of wooded swamps, 194 acres of fresh marsh, 16 acres of intermediate marsh, and 122 acres of agricultural lands to lower value habitat. These conversions would result in an estimated loss of 814 man-days of hunting. This loss would be offset by the substantial reduction in projected loss of recreational opportunities

PLAN 1

- Three salinity control structures with appurtenant channels, one on the east bank and two on the west bank of the Mississippi River.

- 6,600 cfs design capacity at the Big Mar site on the west bank.

- 7,100 cfs design capacity at the Bayou Lasseigne site on the west bank.

- 3,550 cfs design capacity at the Bayou Lasseigne site on the west bank.

B.2.16. The plan would require 1,139 acres for construction and maintenance, relocation of six roads, three railroads, and seven pipelines, and maintenance dredging estimated at 47,100 cubic yards in an average year.

B.2.17. The first cost of Plan 1 is estimated to be $53,900,000 and the benefit-to-cost ratio is 3.0. Average annual benefits over costs are estimated at $10,440,000.

B.2.18. Construction impacts include converting 133 acres of bottomland hardwoods, 484 acres of wooded swamps, 194 acres of fresh marsh, 16 acres of intermediate marsh, and 121 acres of agricultural lands to lower value habitat. These land conversions would cause an estimated loss of 814 man-days of hunting. However, this loss would be offset by the substantial reduction in projected loss of recreational opportunities attributable to the plan. Water quality in the receiving areas would be generally degraded. Specific water quality impacts include alteration of the existing hydraulic regime and sedimentation patterns, and possible accelerated aging of Big Mar and Lac Des Allemands. The diverted water could raise the level of Lac Des Allemands about 2.5

B.2.12. The Federal Government will determine the reasonableness of the costs incurred in acquiring the required real estate interests and credit them to the non-Federal share of the project construction costs upon receipt of certified invoices.

B.2.13. The Federal Government will require the right to enter at reasonable times and in a reasonable manner upon land which the sponsor owns or controls for access to the project.

B.2.14. As part of the operation and maintenance of the project, the non-Federal sponsor will establish an interagency advisory group to participate in decisions governing structure operation. This group should include people from the local, state, and Federal sectors knowledgeable in the multiple needs of fish and wildlife resources, navigation, water supply, and flood control. The sponsor must also maintain a network for collecting climatological, chemical, hydrological, and biological data essential for determining the best use of diverted water. The design and conduct of the long-term monitoring system will be determined by the New Orleans District with the cooperation of the interagency advisory group after the postconstruction monitoring phase is completed. The sponsor will provide timely reports containing collected data and analysis of structure operation and results to the New Orleans District. The district will review the reports to determine whether the structure operation manual should be modified to obtain maximum benefits.

ALTERNATIVE PLANS

B.2.15. The 16 plans and existing and projected 2035 conditions without Federal action are summarized and assessed in tables B-2-4, B-2-5, and B-2-6. The elements of the plans are shown in plate B-2. Factors that differ between plans are described in the following paragraphs.

o 5,325 cfs design capacity at Bayou Lasseigne site on the west bank.

B.2.49. The construction of Plan 12 would require 1,126 acres for construction and maintenance, relocation of four roads, three railroads, six pipelines, and seven camps, and maintenance dredging at 46,100 cubic yards per year.

B.2.50. The first cost of Plan 12 is estimated at $46,700,000. The ratio of average annual benefits to average annual costs is 3.4. The average annual net benefits are estimated at $11,110,000.

B.2.51. Construction impacts include converting 42 acres of bottomland hardwoods, 295 acres of wooded swamp, 132 acres of fresh marsh, 16 acres of intermediate marsh, 211 acres of brackish marsh, and 87 acres of agricultural lands to lower value habitat. The land conversion would result in the loss of 623 man-days of hunting. This loss would be offset by a substantial reduction in projected loss of recreational opportunities attributed to the plan. Water quality in the receiving areas would be generally degraded. Specific water quality impacts associated with this plan include alteration of the existing hydraulic regime and sedimentation patterns, and accelerated aging of Big Mar and Lac Des Allemands. The diverted flow could raise water levels in Lac Des Allemands about 0.6 inches under adverse conditions. Pollutants and coliform bacteria would enter Barataria Bay in greater quantities and water temperatures would be decreased. A very high probability exists of affecting a known archeological site in the Myrtle Grove rights-of-way. Increased flows in Bayou Des Allemands could have erosive impacts on archeological sites along that bayou.

PLAN 13

- Three salinity control structures with appurtenant channels, one on the east bank and two on the west bank of the Mississippi River.

- 6,600 cfs design capacity at Big Mar on the east bank.

- 3,550 cfs design capacity at Myrtle Grove on the west bank.

- 7,100 cfs design capacity at Bayou Fortier site on the west bank.

B.2.52. Plan 13 would require 1,249 acres for construction and maintenance, relocation of five roads, three railroads, six pipelines, and seven camps, and maintenance dredging estimated at 46,400 cubic yards per year.

B.2.53. The first cost of Plan 13 is estimated at $49,100,000. The ratio of average annual benefits to average annual cost is 3.2. Average annual benefits in excess of costs are estimated at $10,890,000.

B.2.54. Construction impacts include converting 149 acres of bottomland hardwoods, 252 acres of wooded swamp, 89 acres of fresh marsh, 16 acres of intermediate marsh, 207 acres of brackish marsh, and 85 acres of agricultural lands to lower value habitat. The land conversion would result in the loss of 702 man-days of hunting. This loss would be offset by a substantial reduction in the projected loss of recreational opportunities attributed to the plan. Water quality in the receiving areas would be generally degraded. Specific water quality impacts associated with this plan include alteration of the existing hydraulic regime and sedimentation patterns, and accelerated aging of Big Mar and Lac Des Allemands. The diverted flow could raise the level of Lac Des Allemands about 0.8 inches under adverse conditions. Pollutants and

coliform bacteria would enter the Barataria Bay in greater quantities and water temperatures would be decreased. A very high probability exists for affecting a known archeological site in the Myrtle Grove rights-of-way, and a high probability exists of affecting cultural remains in the Bayou Fortier rights-of-way. Increased flows in Bayou Des Allemands could have erosive impacts on archeological sites along the bayou.

PLAN 14

- o Three salinity control structures with appurtenant channels, one on the east bank and two on the west bank of the Mississippi River.

- o 6,600 cfs design capacity at Big Mar on the east bank.

- o 3,550 cfs design capacity at Myrtle Grove on the west bank.

- o 7,100 cfs design capacity at Bayou Lasseigne site on the west bank.

B.2.55. Plan 14 would require 1,193 acres for construction and maintenance, relocation of four roads, three railroads, six pipelines, and seven camps, and maintenance dredging estimated at 46,400 cubic yards per year.

B.2.56. The first cost of Plan 14 is estimated at $47,500,000. The ratio of average annual benefits to average annual cost is 3.3. Average annual benefits in excess of costs are estimated at $11,040,000.

B.2.57. Construction impacts include converting 38 acres of bottomland hardwoods, 344 acres of wooded swamp, 154 acres of fresh marsh, 16 acres of intermediate marsh, 207 acres of brackish marsh, and 90 acres of agricultural lands to lower value habitat. The land conversion would

result in the loss of 686 man-days of hunting. This loss would be offset by a substantial reduction in the projected loss of recreational opportunities attributed to the plan. Water quality in three receiving areas would be generally degraded. Specific water quality impacts associated with this plan include alteration of the existing hydraulic regime and sedimentation patterns, and accelerated aging of Big Mar and Lac Des Allemands. The diverted flow could raise the level of Lac Des Allemands about 0.8 inches under adverse conditions. Pollutants and coliform bacteria would enter Barataria Bay in greater quantities and water temperature would be decreased. A very high probability exists for affecting a known archeological site in the Myrtle Grove rights-of-way. The increased flow in Bayou Des Allemands could affect archeological sites along the bayou.

PLAN 15

o Four salinity control structures with appurtenant channels, one on the east bank and three on the west bank of the Mississippi River.

o 6,600 cfs design capacity at Big Mar on the east bank.

o 3,550 cfs design capacity at Myrtle Grove on the west bank.

o 3,550 cfs design capacity at Bayou Fortier site on the west bank.

o 3,550 cfs design capacity at Bayou Lasseigne site on the west bank.

B.2.58. Plan 15 would require 1,464 acres for construction and maintenance, relocation of seven roads, four railroads, eight pipelines, and seven camps, and maintenance dredging estimated at 46,500 cubic yards per year.

B.2.59. The first cost of Plan 15 is estimated at $54,500,000. The ratio of average annual benefits to average annual cost is 2.9. Average annual benefits in excess of costs are estimated at $10,360,000.

B.2.60. Construction impacts include converting 121 acres of bottomland hardwoods, 405 acres of wooded swamp, 145 acres of fresh marsh, 16 acres of intermediate marsh, 207 acres of brackish marsh, and 126 acres of agricultural lands to lower value habitat. The conversion would result in the loss of 731 man-days of hunting. This loss would be offset by a substantial reduction in the projected loss of recreational opportunities attributed to the plan. Water quality in the receiving areas would be generally degraded. Specific water quality impacts associated with this plan include alteration of the existing hydraulic regime and sedimentation patterns, and accelerated aging of Big Mar and Lac Des Allemands. The diverted flow could raise the level of Lac Des Allemands about 0.8 inches under adverse conditions. Pollutants and water temperatures would be decreased. A very high probability exists of affecting a known archeological site in the Myrtle Grove rights-of-way. Increased flows in Bayou Des Allemands could have erosive impacts on archeological sites along the bayou.

PLAN 16

o Two salinity control structures with appurtenant channels and levees, one on the east bank and one on the west bank of the Mississippi River.

o 6,600 cfs design capacity at the Big Mar site on the east bank.

o 10,650 cfs design capacity at the Davis Pond site on the west bank.

B.2.61. Plan 16 would require 685 acres for construction and maintenance, relocation of three roads, three railroads, and 10 pipelines. To prevent flooding of adjacent areas and assure ponding in the 7,425-acre overflow area would require 15.4 miles of levees and five weirs. To redirect intercepted drainage would require clearing and snagging 7.9 miles of drainage and navigation canals, and addition of a new drainage canal, a new pumping station with a capacity of 260 cfs, and a pump with a 100 cfs capacity at the St. Charles Parish pumping station on Cousin Canal. Maintenance dredging is estimated at 19,800 cubic yards per year.

B.2.62. The first cost of Plan 16 is estimated at $47,400,000. The ratio of average annual benefits to average annual costs is 3.3. Average annual benefits in excess of costs are estimated at $11,000,000.

B.2.63. Construction impacts include converting 122 acres of bottomland hardwoods, 118 acres of wooded swamp, 109 acres of fresh marsh, and 51 acres of agricultural and developed lands to lower value habitat. Excess dredged material would be used to create 175 acres of marsh. The conversion would result in the loss of 338 man-days of hunting. This loss would be offset by a substantial reduction in the projected loss of recreational opportunities attributed to the plan. Water quality in the receiving areas would be generally degraded. Specific water quality impacts associated with the plan include alteration of the existing hydraulic regime and sedimentation patterns, and possible accelerated aging of Big Mar and Lake Cataouatche. However, dispersion of the water over the 7,425-acre Davis Pond overflow area would allow the water to warm, and 5 to 20 percent of the pollutants, 60 to 90 percent of the sediment, and 12 percent of the fecal coliform bacteria to be removed. The remainder of the fecal coliform bacteria would die off in Lake Cataouatche and Salvador. Over a 50-year period, a delta would form in the overflow area covering four square miles and ranging from 1 to 4 feet in thickness with an ultimate elevation between 2 and 3 feet. A

high probability exists for encountering cultural remains along Bayous Bois Piquant and Verret. The diverted water could raise the level of Lake Cataouatche about 4 inches and Lake Salvador about 1 inch under adverse conditions.

Section 3. TRADE-OFF ANALYSIS

PLAN COMPARISON

ECONOMIC EVALUATION

B.3.1. First Cost. Table B-3-1 shows a cost summary for the 16 plans. All plans include the Big Mar site in the Breton Sound Basin with an estimated first cost of $15.3 million. The estimated first cost for the Barataria Basin depends on the number of diversion structures, amount of relocations, and quantity of excavation required by a particular plan. The estimated first costs of the plans range between $44.7 and $54.7 million. Plans 2, 5, 7, 9, 12, and 14 use the Bayou Lasseigne site as the primary diversion location. Plans 1, 4, 6, 8, 11, and 13 use Bayou Fortier as the primary diversion location. Plan 16 uses Davis Pond as the diversion site. Comparing plans using the Bayou Lasseigne site with plans using the Bayou Fortier site (Plans 1 and 2, 4 and 5, 6 and 7, 8 and 9, 11 and 12, and 13 and 14) reveals that the Bayou Lasseigne plans are less costly because fewer relocations and less excavation are necessary. Comparing Plan 16, with a single structure at Davis Pond, and the other plans reveals that plans using the Bayou Lasseigne and Bayou Fortier sites in combination with each other (plans 1, 2, 3, 10, and 15) are most costly and all others are less costly. Plan 16 is costly because of the relocations necessary and drainage features required to mitigate effects on local drainage. However, the difference in cost between Plan 16 at $47,400,000 and Plan 15, the least costly plan at $44,200,000, is only about 7 percent. Plan 15, with an equal division of flow between the Bayou Lasseigne, Bayou Fortier, and Myrtle Grove sites, is the most costly at $54,500,000. Rankings of the plans are shown in tables B-2-4, B-2-5, and B-2-6.

B.3.2. Operation and Maintenance. The estimated annual operation and maintenance (O&M) cost varies between $471,000 and $553,000. This cost

TABLE B-3-1

SUMMARY OF ECONOMIC ANALYSES OF ALTERNATIVES

Plans	Basin Element	First Cost	Annual Costs	Annual Benefits	Net Benefits	Benefit to Cost Ratio
1	Breton Sound	15,300	1,500	6,050	4,550	
	Barataria	38,600	3,820	9,710	5,890	3.0
	Total	53,900	5,320	15,760	10,440	
2	Breton Sound	15,300	1,500	6,050	4,550	
	Barataria	37,400	3,710	9,710	6,000	3.0
	Total	52,700	5,210	15,760	10,550	
3	Breton Sound	15,300	1,500	6,050	4,550	
	Barataria	38,600	3,820	9,710	5,890	3.0
	Total	53,900	5,320	15,760	10,440	
4	Breton Sound	15,300	1,500	6,050	4,550	
	Barataria	32,300	3,200	9,710	6,510	3.4
	Total	47,600	4,700	15,760	11,060	
5	Breton Sound	15,300	1,500	6,050	4,550	
	Barataria	28,900	2,900	9,710	6,810	3.6
	Total	44,200	4,400	15,760	11,360	
6	Breton Sound	15,300	1,500	6,050	4,550	
	Barataria	31,700	3,180	9,710	6,530	3.4
	Total	47,000	4,680	15,760	11,080	
7	Breton Sound	15,300	1,500	6,050	4,550	
	Barataria	30,000	3,030	9,710	6,680	3.5
	Total	45,300	4,530	15,760	11,230	
8	Breton Sound	15,300	1,500	6,050	4,550	
	Barataria	32,400	3,240	9,710	6,470	3.3
	Total	47,700	4,740	15,760	11,020	
9	Breton Sound	15,300	1,500	6,050	4,550	
	Barataria	30,800	3,100	9,710	6,610	3.4
	Total	46,100	4,600	15,760	11,160	
10	Breton Sound	15,300	1,500	6,050	4,550	
	Barataria	37,800	3,780	9,710	5,930	3.0
	Total	53,100	5,280	15,760	10,480	
11	Breton Sound	15,300	1,500	6,050	4,550	
	Barataria	33,100	3,310	9,710	6,400	3.3
	Total	48,400	4,810	15,760	11,950	
12	Breton Sound	15,300	1,500	6,050	4,550	
	Barataria	31,400	3,150	9,710	6,560	3.4
	Total	46,700	4,650	15,760	11,110	
13	Breton Sound	15,300	1,500	6,050	4,550	
	Barataria	33,800	3,370	9,710	6,340	3.2
	Total	49,100	4,870	15,760	10,890	
14	Breton Sound	15,300	1,500	6,050	4,550	
	Barataria	32,200	3,220	9,710	6,490	3.3
	Total	47,500	4,720	15,760	11,040	
15	Breton Sound	15,300	1,500	6,050	4,550	
	Barataria	39,200	3,900	9,710	5,810	2.9
	Total	54,500	5,400	15,760	10,360	
16	Breton Sound	15,300	1,500	6,050	4,550	
	Barataria	32,100	3,260	9,710	6,450	3.3
	Total	47,400	4,760	15,760	11,000	

includes the O&M for a monitoring program, structures, maintenance dredging of the channels, and increased maintenance dredging in the Mississippi River, Southwest Pass. The cost per site depends on the number of sites in the plan. The major differences in the O&M costs between plans depends on the amount of channel maintenance dredging. Plan 5, with the Bayou Lasseigne site in the Barataria Basin, is the least costly at $471,000. Plan 4 has identical O&M costs. Plan 16, with the Davis Pond site in the Barataria Basin, costs an estimated $545,000. Although Plan 16 has only one site in the Barataria Basin, the high cost is due to the maintenance of the extensive drainage canals and levee system. Plan 15, with four sites, is the most costly at $553,000.

B.3.3. Average Annual Costs. The average annual costs of the plans range between $4,400,000 and $5,400,000. This cost includes $615,000 in lost oyster production. Plan 5 with two structures is the least costly and has annual charges of $4,400,000. Plan 7, which apportions the flow equally between Bayou Lasseigne and Oakville, is the second least costly at $4,530,000. Plan 16 with two structures is the ninth most costly at $4,760,000. Plan 15 with four sites is the most costly at $5,400,000.

B.3.4. Benefits. All 16 plans are economically justified. The tangible (monetary) benefits are the same for all plans. The average annual benefits to the commercial and recreational fish and wildlife resources are estimated at $15,764,000. About 94 percent of the benefits or $14,903,000 are attributed to commercial fisheries, 2 percent or $291,000 to commercial wildlife, 1 percent or $135,000 to sport fishing, and 3 percent or $435,000 to sport hunting. The oyster fishery is the largest benefit category accounting for 90 percent of the total tangible benefits, followed by shrimp, menhaden, blue crab, Atlantic croaker, seatrout, spot, and red drum with 4 percent. Approximately 62 percent of the total benefits would be in the Barataria Basin.

B.3.5. The plans would produce other tangible and intangible benefits that were not quantified. They include increased plant species diversity, improved habitat for nongame and noncommercial species, improved productivity of wooded swamps and associated freshwater fish and wildlife, increased potential for recreation, minimized loss of marsh capacity to buffer hurricane tides and to treat wastewater, enhanced property values, and better maintained unique cultural heritage and lifestyles of the coastal fishing and trapping communities.

B.3.6. The magnitude of the unquantified benefits varies between plans and is related to the point of diversion and the quantity of flow diverted. Plans 1 through 5, which introduce all the flow in the upper basins, produce the most unquantified benefits. These plans allow the freshwater to remain in the basins the longest time and benefit the largest area, thus producing the most benefits. Plans 6 through 16 decrease the flow through the upper basin, thereby reducing the size of the area benefited and unquantified benefits. Plan 16 does benefit areas of wetlands that would not be benefited by other plans. Therefore, the difference in area benefited by Plan 1 through 5 and Plan 16 is slight.

B.3.7. Benefit-to-cost ratios. Based on the monetary benefits, all 16 plans have a favorable benefit-to-cost (B/C) ratio. The B/C ratios range between 3.6 and 2.9. Each plan includes the Breton Sound Basin element with a B/C ratio of 4.0. The Barataria Basin element of Plan 5 with one site has the highest B/C ratio, 3.4. The overall B/C ratio for the plan is 3.6. Plan 7 with two structures in the Barataria Basin has an overall B/C ratio of 3.5. Plans 6, 9, and 12 with two sites in the Barataria Basin have the third highest overall B/C ratio of 3.4. Plan 16 has an overall B/C ratio of 3.3, and the Barataria Basin element with one site has a B/C ratio of 3.0. Plan 15 has the lowest overall B/C ratio, 2.9. The B/C ratios for the plan are shown in table B-3-1.

B.3.8. Excess benefits over cost. The net benefits range between $11,360,000 for Plan 5 and $10,360,000 for Plan 15. Each plan includes the Breton Sound Basin element with $4,550,000 in excess benefits over costs. The Barataria element in Plan 5 produces the most net benefits, $6,810,000. Plan 7 yields the second highest excess benefits over costs, $11,230,000, and the Barataria element yields $6,680,000. Plan 16 produces net benefits of $11,000,000. Plan 15 has the lowest net benefits, $10,360,000. Table B-3-1 displays the net benefits for the plans.

ENVIRONMENTAL QUALITY EVALUATION

B.3.9. Wetlands. All plans would result in saving 99,162 acres of marsh: 82,690 acres in the Barataria Basin and 16,472 acres in the Breton Sound Basin. The plans also produce a number of intangible benefits, as previously discussed. The amount of intangible benefits generated by an individual plan depends on the point of freshwater introduction and the quantity of flow. Plans 1 through 5 introduce all flow in the upper portions of the basins. This point of introduction would affect the largest area and produce the most beneficial effects on the wetlands. Plans 6 through 15 that introduce a portion of the flow lower down in the Barataria Basin would induce fewer benefits. Plan 16 introduces flows farther down in the basin than Plans 1 through 5 but the area benefited is only slightly less. The adverse construction impacts of the plans vary depending on the quantity of excavation required. Plan 16 would require the least amount of wetlands, 349 acres. Plan 5 with slightly more excavation would require the second smallest area, 610 acres. Construction of Plan 15 would affect the largest area, 894 acres. A comparison of the impacts on the wetlands is summarized in table B-2-4, B-2-5, and B-2-6.

B.3.10. Water Bodies. Although waterbodies would continue to expand, all plans would reduce the rate of expansion by about 3.1 square miles

per year. There would be a net reduction of 99,162 acres in growth of the water bodies over the 50-year project life. Construction of the outlet channels will affect several existing streams. Plan 5 would alter the smallest area, 72 acres, and Plan 9 would alter the second smallest area. Plan 11 would affect the largest water area, 391 acres. The acreage of water bodies affected by the plans is shown in table B-2-4, B-2-5, and B-2-6.

B.3.11. Water Quality. In all plans, diverting Mississippi River water would alter salinities in the receiving waters and maintain desirable salinity gradients. The introduction of Mississippi River water would have other beneficial and adverse impacts. The magnitude of the impacts varies by plan. All of the plans have the same impact on the Breton Sound estuary. The differences between plans, therefore, are in the Barataria Basin element and are related to the point of diversion. All plans would improve oxygen supplies and circulation and would flush stagnant waters from the basin. These beneficial impacts would be greater with Plans 1 through 5, which divert near the head of Barataria Basin where oxygen demand is greatest. Plan 16 is the next most beneficial in this respect. Plans 6 through 15 would have a lesser impact. Since Mississippi River water has higher concentrations of some pollutants than the receiving waters, potential adverse impacts vary. Turbidity, water temperature, and fecal coliform bacteria would be significantly less with Plan 16. Pollutants such as heavy metals, pesticides, and herbicides would be less with Plan 16. With Plans 1 through 5, the water quality impacts would be most notable in Lac Des Allemands, the initial receiving water body. These impacts would include an increase in water temperature, turbidity, fecal coliform bacteria, and some pollutants. The long detention time, however, would permit some pollutants to settle out and the cooler river water to warm before reaching the sensitive estuarine areas. Plans 6 through 10 introduce water lower in the basin than Plans 1 through 5 and Plan 16. Plans 6 through 10 would have a shorter detention time before the water reached the

sensitive estuarine areas, and the potential adverse impacts would increase. Plans 11 through 15, which discharge directly into Barataria Bay, would abruptly alter water quality gradients and would have the most potential adverse impacts. From a water quality viewpoint, Plan 16 is superior. The water quality impacts of the plans are summarized in tables B-2-4, B-2-5, and B-2-6.

B.3.12. Prime and unique farmland. All impacts on prime farmland would be limited to the construction sites. Plan 16, requiring 40 acres, would produce the least impacts on prime farmland. Plans 6-9 affect 60 to 71 acres, Plans 4, 5, and 11-14 affect 82 to 90 acres, and Plans 1-3 and 10 affect 107 to 123 acres. Plan 15 affects 126 acres and would have the most impact.

B.3.13. Endangered species. The plans are not expected to significantly affect any endangered species. However, the potential exists for adversely affecting the bald eagle and brown pelican, which could be exposed to increased pollutant levels. Five bald eagle territories located in the Barataria Basin could be affected. The bald eagle nest located near Lake Cataouatche would have the greatest potential for adverse impacts. Plan 16 would affect this nesting territory. The Corps has concluded formal consultation with the USFWS concerning potential impacts on bald eagles. Endangered species assessments and correspondence with the USFWS concerning this matter are in Appendix D, Section 2. Plans 1 through 5 and Plan 16 would pose the least chance of impact on the brown pelican colony on Queen Bess Island at the lower end of the basin. Plans 6 through 15, with diversion in the lower portion of the basin, would have greater potential of adverse impacts on the brown pelican.

B.3.14. Fish and Wildlife. The monetary fish and wildlife benefits would be similar for all plans. All plans would enhance habitat conditions and improve production of noncommercial and nongame species.

AD-A152 704 LOUISIANA COASTAL AREA LOUISIANA FRESHWATER DIVERSION TO BARATARIA AND BR..(U) ARMY ENGINEER DISTRICT NEW ORLEANS LA D L CHEW SEP 84 3/7

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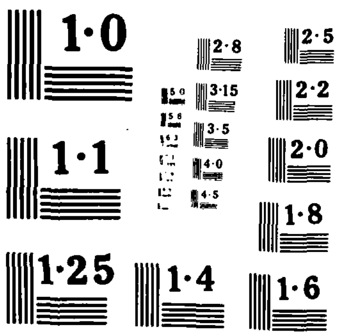
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Plans 1 through 5, however, would provide the greatest benefit to non-commercial and nongame species since these plans would enhance the largest area. Plan 16 would be only slightly less beneficial since the number of acres enhanced is only slightly less. Plans 1 through 15 could possibly alter catfish spawning and species in Lac Des Allemands. With Plans 6 through 15, the necessity to close oyster harvesting areas could be increased during time of diversion. Plan 16 would not impact the catfish fishery in Lac Des Allemands. The plan would benefit the Salvador Wildlife Mangement Area by nourishing the public marshes. Controlling water levels in the 7,425-acre overflow area would also permit management of the area to improve waterfowl hunting. Though Plan 5 provides more habitat enhancement benefits than Plan 16, Plan 16 has the least potential for adverse impacts on the fish and wildlife resources. All plans would decrease oyster production of 15,383 leased areas.

B.3.15. National Register of Historic Places. No National Register or Register-eligible properties occur within the rights-of-way of the proposed plan. Plans 1 through 4, and 6, 9, 10, 11, 13, and 15, which include the Bayou Fortier and Myrtle Grove sites, and Plan 16, which includes the Davis Pond site, would have a high probability of encountering cultural remains.

SOCIAL WELL-BEING AND REGIONAL DEVELOPMENT EVALUATION

B.3.16. All plans would make positive, long-term contributions to social well-being. The plans would help maintain the unique and traditional lifestyles in the area associated with fishing and trapping. They would increase business activity, employment opportunities, and income in the industries that depend on the fish and wildlife resources and in the support industries. These increases would induce slight increases in property values and tax revenues derived from these sources and in fish and wildlife-related industries. Construction of the plans

would temporarily disrupt vehicular traffic and cause a slight increase in noise levels. Three businesses would be displaced by Plans 6 through 10, and seven camps by Plans 11 through 15. Plans 1 through 5 and Plan 16 would have the least adverse impacts on social well-being and regional development.

B.3.17. The plans were examined to determine if changes in design and construction could contribute to the national objective of water conservation. Water conservation for this purpose was defined as any beneficial reduction in water use or in water losses. The plans would divert water to reduce saltwater intrusion in Barataria and Breton Sound Basins. The river water would have an adverse effect on water quality of the receiving water bodies, but would establish salinity gradients beneficial to the production of fish and wildlife. The diverted flows are small compared to the flows available in the river. The overall effects of the plans on the river are not considered significant, but will be highly beneficial to fish and wildlife.

IMPLEMENTATION EVALUATION

B.3.18. All plans include one or more sites in the Barataria Basin and one site in the Breton Sound Basin. In the Breton Sound Basin, the Big Mar site has received widespread support from the public and from local and state officials. Louisiana Governor Treen has furnished a letter of intent to participate in the construction of the Big Mar site (Exhibit 3). In the Barataria Basin, Plans 1 through 5 use sites at Bayou Lasseigne and Bayou Fortier to divert the required flow into Lac Des Allemands. During presentation of the array of plans to the public, officials and residents of St. Charles, St. James, and St. John the Baptist Parishes expressed opposition to any plan that uses Lac Des Allemands as the primary receiving water body. The public believes that these plans would aggravate natural flood conditions and adversely affect the catfish industry in the area so important to the local

economy. Thus, Plans 1 through 5 are not considered implementable because of strong local opposition. Plaquemines Parish officials have indicated support for the Oakville and Myrtle Grove sites. However, these sites must be combined with an upstream site to achieve study objectives. The Lac Des Allemands sites are combined with the Oakville site in Plans 6 through 10, with the Myrtle Grove site in Plans 11 through 15. Public opposition to the Lac Des Allemands sites makes Plans 6 through 15 not implementable. Plan 16, which diverts water into Lake Cataouatche, has received tentative support from local officials and the public. Governor Treen has furnished a letter of intent to participate in construction of the Davis Pond site (Exhibit 4). Thus Plan 16, with sites at Big Mar in the Breton Sound Basin and Davis Pond in the Barataria Basin, was designated as the most implementable plan.

RATIONALE FOR NATIONAL ECONOMIC DEVELOPMENT PLAN

B.3.19. Plan 5 is the least costly and yields the maximum excess benefits over cost of the 16 alternative plans. The plan is designed to maintain the 5 ppt isohaline at the brackish-saline marsh interface and the 15 ppt isohaline along the southern margin of the historical oyster harvesting areas. Maintaining the isohalines will optimize the distance between the two isohalines and the area of broad, low-salinity zones in the marshes and estuaries. Modification of Plan 5 to divert less or more than the optimal flow of 17,250 cfs would move the positions of the 5 and 15 ppt salinity isohalines inland or seaward of the desired locations. Maintaining the isohalines further inland by diverting less flow reduces the area affected and consequently project benefits. For less than optimal flows, the relationship between diverted flows and benefits are directly proportional. Maintaining the isohalines further seaward overly freshens the area and narrows the distance between the 5 and 15 ppt isohalines. This will increase wildlife productivity but reduce fish productivity and, consequently, project benefits. The following tabulation shows the first cost, annual charges, and benefits for

Plan 5, a smaller discharge capacity plan (Plan 5A), and a larger discharge capacity plan (Plan 5B).

Plan	Discharge Capacity (cfs)	First[1/] Cost ($000)	Annual[2/] Charges ($000)	Annual Benefits ($000)	Net Benefits ($000)
Plan 5A	11,500[3/]	35,100	3,350	10,570	7,220
Plan 5	17,250	44,200	4,400	15,760	11,360
Plan 5B	20,800[4/]	52,300	5,200	less than 15,760	less than 10,560

1/ Based on October 1983 price levels.

2/ Based on 50-year project life and 8 1/8% interest rate.

3/ Includes discharge capacities of 4,400 cfs into Breton Sound at Big Mar site and 7,100 cfs into Barataria Basin at Bayou Lasseigne site.

4/ Includes discharge capacities of 6,600 cfs into Breton Sound at Big Mar site and 14,200 cfs to Barataria Basin at Bayou Lasseigne site (10,650 cfs) and Oakville site (3,550 cfs).

B.3.20. The data in the tabulation shows Plan 5 yields the maximum excess of benefits over cost for either a smaller or larger discharge capacity plan. Therefore, Plan 5 yields the maximum excess of benefits over cost of any plan.

B.3.21. In addition, Plan 5 has the greatest benefit-to-cost ratio and contributes the maximum intangible benefits. The plan would involve less disruption of existing facilities than the other freshwater diversion plans and would have fewer adverse environmental impacts. Thus, Plan 5 was designated as the National Economic Development (NED) plan.

RATIONALE FOR RECOMMENDED PLAN

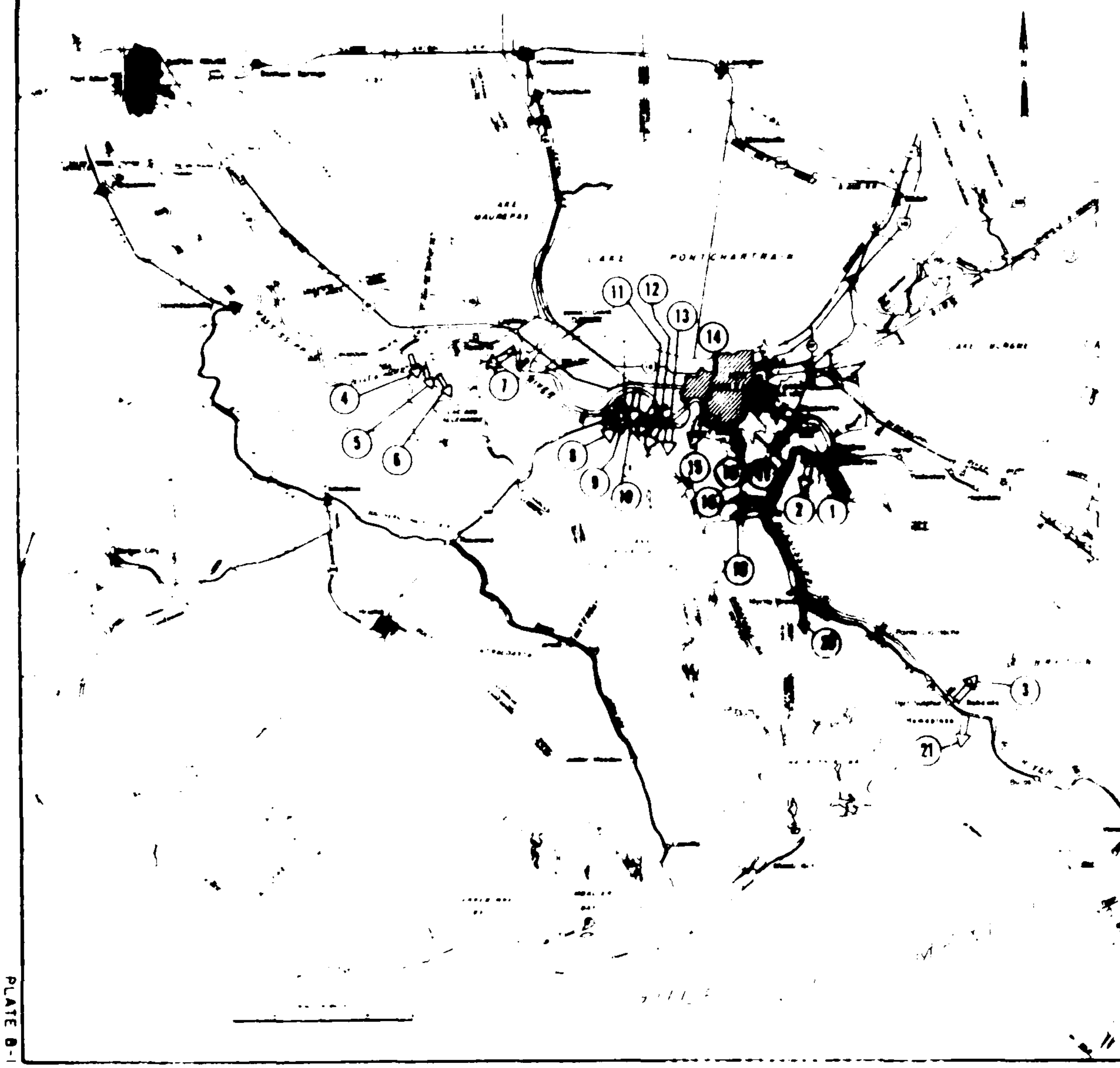
B.3.22. In all 16 plans, freshwater is diverted into Breton Sound Basin through Big Mar. To divert freshwater into Barataria Basin, three basic approaches were selected. Plans 1 through 5 represent one approach: divert all flow into Lac Des Allemands in upper Barataria Basin. Plans 6 through 15 use another approach: divide the diversion between sites in upper Barataria Basin and sites in the lower basin. Plan 16 is a third approach: divert all flows into Lake Cataouatche, which is between the upper and lower Barataria Basin sites.

B.3.23. The approach in Plans 1 through 5 produces the most intangible benefits and the least costly plan, Plan 5. However, this group of plans has the potential of adversely affecting water quality and the locally important catfish fishery in Lac Des Allemands and lacks public support. The approach in Plans 6 through 15 would produce the least intangible benefits. This group of plans also has the most significant potential for adversely affecting the environment and social and cultural resources in the receiving areas in Barataria Basin. Thus, Plans 6 through 15 are not highly desirable. The approach in Plan 16 produces only slightly fewer intangible benefits than Plans 1 through 5, has the least potential of all plans for adversely affecting the environment in the Barataria Basin receiving areas, and enjoys public support. The two most desirable plans from an overall viewpoint, therefore, are Plan 5 and Plan 16.

B.3.24. The trade-off analysis between Plans 5 and 16 is primarily concerned with the individual diversion locations in Barataria Basin and the impact area. The major considerations are: cost, water quality in the receiving water bodies, potential adverse impacts on the catfish fishery in Lac Des Allemands, the habitat area enhanced, and publc support. A pivotal factor in these considerations is that Plan 16 contains a 7,425-acre marsh overflow area in which the diverted water

will be detained. With the overflow area, potential adverse impacts should be reduced and more direct intangible benefits would be provided in the immediate area of the diversion. At the diversion location in Plan 5, a similar marsh overflow area is not possible because Lac Des Allemands serves as the initial overflow area. Using the lake as the initial receiving area could have a severe impact on water quality and the catfish fishery. A land overflow area for Plan 5 would require using agricultural lands, which would increase the cost of the plan. Unlike Plan 16, where the overflow area is benefited, a land overflow area for Plan 5 would result in loss of production and, in effect, would substitute one adverse impact for another. Plan 5 does, in fact, enhance a slightly larger habitat area than Plan 16. However, Plan 16 would more directly enhance the immediate area receiving the diversion as well as the Salvador Game Management Area. The fact that Plan 16 has public support and Plan 5 has public opposition weighs heavily in favor of Plan 16.

B.3.25. In the trade-off analysis, the attributes of Plan 16 outweighed those of Plan 5. As a result of the analysis, Plan 16 was selected as the recommended plan.



BRETON SOUND BASIN

	SITE NAME	RECEIVING WATER BODY
1	CAERNARVON CANAL	LAKE LERY
2	NEAR CAERNARVON	BIG MAR
3	BOHEMIA	AMERICAN BAY

BARATARIA BASIN

	SITE NAME	RECEIVING WATER BODY
4	BAYOU BECNEL	LAC DES ALLEMANDS
5	JOHNSON	
6	BAYOU LASSEIGNE	
7	BAYOU FORTIER	
8	DAVIS POND	LAKE CATAOUATCHE
9	LENOUX CANAL	
10	SELLERS CANAL	
11	SAUL'S CANAL	
12	WILLSWOOD CANAL	
13	WAGGAMAN CANAL	
14	AVONDALE CANAL	
15	BAYOU SEGNETTE	
16	HARVEY LOCK	BAYOU BARATARIA
17	ALGIERS LOCK	
18	HERO CANAL	
19	OAKVILLE	
20	MYRTLE GROVE	
21	HOMEPLACE	ADAMS BAY

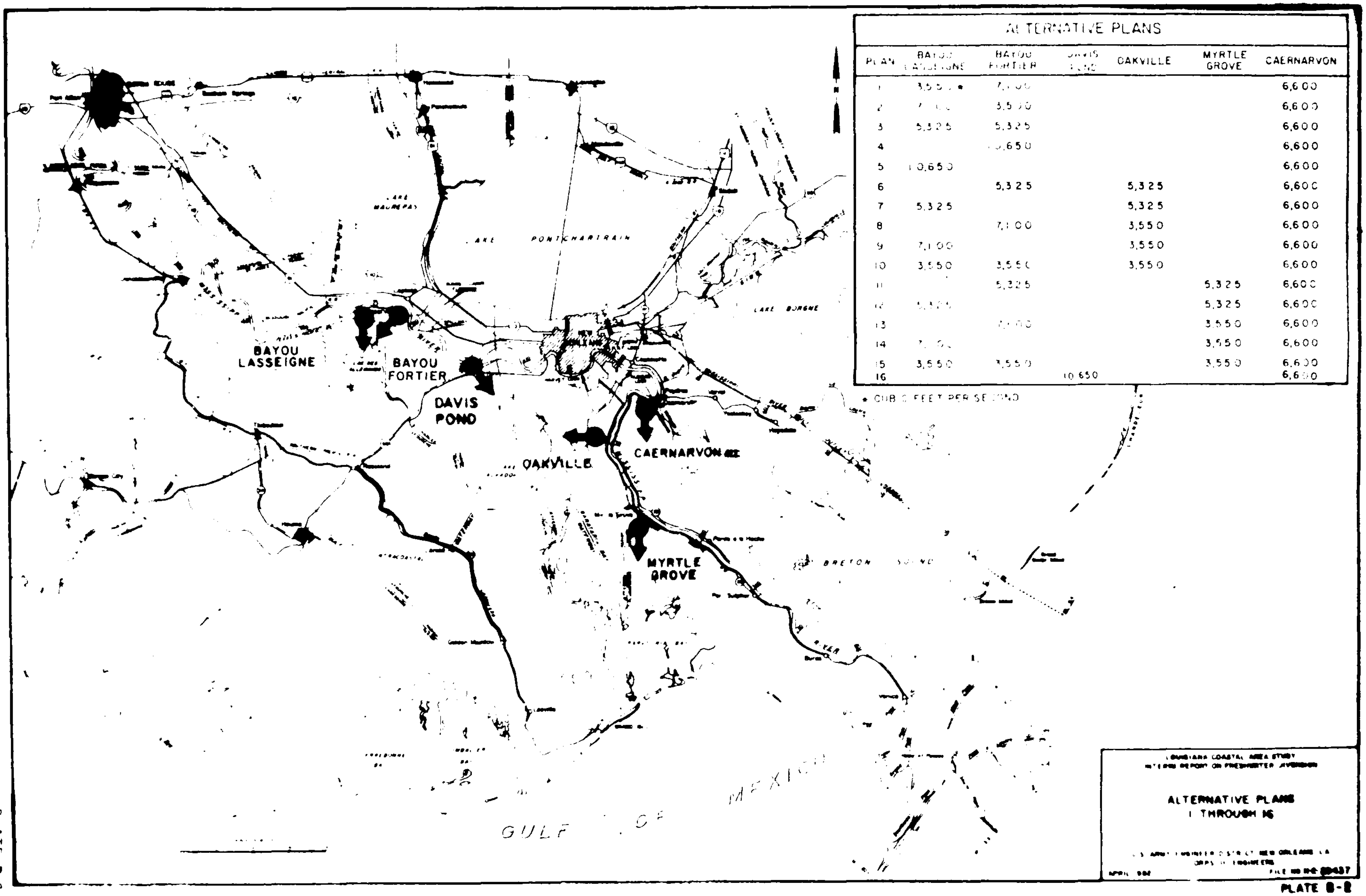
LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

POTENTIAL FRESHWATER DIVERSION SITES

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA
CORPS OF ENGINEERS

APRIL 1982 FILE NO H-8-29437

PLATE B-1



ALTERNATIVE PLANS

PLAN	BAYOU LASSEIGNE	BAYOU FORTIER	DAVIS POND	OAKVILLE	MYRTLE GROVE	CAERNARVON
1	3,550 *	7,100				6,600
2	7,100	3,550				6,600
3	5,325	5,325				6,600
4		10,650				6,600
5	10,650					6,600
6		5,325		5,325		6,600
7	5,325			5,325		6,600
8		7,100		3,550		6,600
9	7,100			3,550		6,600
10	3,550	3,550		3,550		6,600
11		5,325			5,325	6,600
12	5,325				5,325	6,600
13		7,100			3,550	6,600
14	7,100				3,550	6,600
15	3,550	3,550			3,550	6,600
16			10,650			6,600

* CUBIC FEET PER SECOND

LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

ALTERNATIVE PLANS
1 THROUGH 16

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA
CORPS OF ENGINEERS

PLATE B-2

APPENDIX C

ENGINEERING INVESTIGATIONS

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the spring of 1943, from 1951 through 1953, from 1962 to 1963, and from 1968 through 1970. These data indicate that a drought occurred 7 years in 30, or approximately 25 percent of the period of record.

WINDS

C.1.9. The general circulation of air over the area is dominated by the western extension of the Bermuda High. The circulation is also influenced by high pressure systems over the North American continent. The Bermuda High has greater constancy than the continental high pressure systems and controls the spring and summer climate to a large degree. By late autumn, the continental high pressure system penetrates the area. These systems produce winds with a prevailing direction from the east-northeast (table C-1-6).

C.1.10. From September through February, winds from the northeast predominate over winds from the southeast. From March through August, southeast winds predominate. The relatively constant winds from the east and south travel a great distance over the gulf and carry warm, moist air that fuels the cumuliform cloud development so common to summer.

C.1.11. The lowest average wind speeds occur during the summer. This period is occasionally interrupted by tropical storms that produce winds of extremely high velocities. Autumn is the transition from a tropical wind regimen to a modified continental wind regimen. In winter, the cold high pressure systems from the north penetrate the gulf area and bring some prevailing northerlies. Because of the "northers," the winter has the highest average annual wind speeds and the greatest frequency of winds in excess of 38 mph. Wind speeds for two stations adjacent to the study area are presented in tables C-1-1 and C-1-2.

Southeastern Louisiana Climatic Division

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVG ANN
1941	-0.15	-0.18	-0.17	-0.86	-1.01	0.60	0.82	-0.49	-0.43	-0.25	-0.41	-0.37	-0.24
1942	-0.84	1.43	1.65	0.83	0.95	2.34	2.32	2.78	2.75	3.19	-0.47	-0.37	1.38
1943	-0.69	-1.29	-0.65	-1.34	-1.54	-1.48	-1.58	-2.09	1.68	1.13	0.89	0.78	-0.52
1944	2.14	1.72	1.40	2.10	0.03	-0.43	-0.95	-0.86	-0.97	-1.33	1.29	-0.48	0.31
1945	-0.22	-0.18	-0.92	-1.24	-1.37	-1.65	0.95	1.39	1.35	1.29	0.74	1.51	0.14
1946	1.74	1.33	2.58	1.77	3.01	3.91	3.80	2.90	3.65	2.70	2.39	1.78	2.63
1947	2.73	2.33	2.66	2.99	0.02	-0.13	-1.22	-1.45	-1.87	-2.22	1.70	2.53	0.67
1948	2.66	1.62	3.18	-0.75	-1.07	-1.68	-1.78	-1.87	1.63	1.11	2.84	2.57	0.71
1949	1.66	1.13	1.82	2.72	-0.81	-0.88	0.17	0.16	0.59	0.73	-0.61	-0.40	0.52
1950	-1.22	-1.52	0.28	0.94	-0.49	-0.37	-0.04	-0.92	-1.62	-1.79	-2.30	-1.69	[illegible]
1951	-1.65	-2.02	-1.49	-0.83	-1.16	-1.62	-1.83	-2.68	-2.42	-2.70	-2.56	-2.93	-1.99
1952	-3.35	-1.91	-2.13	-1.55	-1.20	-1.83	-1.84	-1.97	-2.18	-2.54	-2.71	-2.55	-2.15
1953	-2.83	-2.07	-2.26	-1.65	-2.22	0.39	0.78	1.13	-0.82	-1.37	0.93	2.75	-0.60
1954	0.03	-0.90	-1.45	-2.09	-1.92	-2.05	0.88	-0.89	0.02	0.22	0.01	0.36	-0.65
1955	0.69	-0.24	-1.31	1.10	-1.56	-1.79	0.51	1.29	-0.17	-0.30	-0.16	-0.40	-0.20
1956	-0.45	0.57	-0.44	-0.63	-0.71	1.00	0.95	0.51	1.48	-0.42	-0.82	-0.64	0.03
1957	-1.49	-1.82	0.56	1.08	-0.46	0.50	-0.56	-0.54	1.04	0.95	1.37	0.75	0.12
1958	1.73	1.78	2.08	1.38	1.93	1.78	2.09	2.30	2.47	-0.11	-0.63	-1.35	1.29
1959	-1.34	1.09	0.74	0.60	1.53	2.44	3.48	3.20	2.48	3.53	-0.37	-0.95	1.37
1960	-0.74	-0.34	-0.58	-0.41	-0.45	-1.12	-1.83	0.41	0.18	0.56	-0.76	-0.78	-0.49
1961	0.75	1.31	1.73	1.38	1.36	2.35	2.22	2.56	2.51	2.01	2.53	2.79	1.96
1962	2.65	-1.01	-1.43	-1.81	-2.64	-2.29	-3.18	-353	-3.81	-3.71	-3.68	-3.86	-2.36
1963	-3.52	-2.84	-3.49	-4.25	-4.72	-4.03	-4.01	-4.61	-4.13	-4.52	0.87	1.20	-3.17
1964	2.16	2.77	2.62	-0.01	-0.37	-0.61	0.62	-0.21	-0.75	-0.01	-0.07	-0.70	0.45
1965	0.22	0.65	-0.23	-1.28	-1.71	-1.98	-2.14	0.14	0.72	-0.33	-0.84	0.64	-0.51
1966	2.64	4.11	3.11	2.08	3.80	3.01	3.09	2.97	2.78	2.63	1.92	2.38	2.96
1967	2.24	2.42	-0.65	-1.52	-1.52	-1.59	-1.62	0.78	0.77	1.32	-0.06	1.43	0.17
1968	-0.64	-0.76	-1.09	-1.37	-1.18	-1.36	-1.76	-2.07	-2.56	-2.77	-0.01	0.48	-1.26
1969	0.36	0.30	0.76	0.99	1.47	-0.78	-0.68	-0.66	1.31	-1.76	-2.28	-2.09	-0.47
1970	-1.98	-2.23	-1.46	-2.37	-1.95	-1.95	-2.10	0.37	0.31	1.07	-0.40	-0.82	-1.13

SOURCE: Office of State Climatologist, Louisiana State University, Baton Rouge.

INDEX	CHARACTER OF RECENT WEATHER	INDEX	CHARACTER OF RECENT WEATHER
6.00 to 4.00	Very much wetter than normal	-0.50 to -0.99	Incipient drought
3.99 to 3.00	Much wetter than normal	-1.00 to -1.99	Mild drought
2.99 to 2.00	Moderately wetter than normal	-2.00 to -2.99	Moderate drought
1.99 to 1.00	Slightly wetter than normal	-3.00 to -3.99	Severe drought
0.99 to 0.50	Incipient wet spell	-4.00 to -6.00	Exreme drought
0.49 to -0.49	Nearly normal		

TABLE C-1-3

TEMPERATURE NORMALS BY CLIMATOLOGICAL DIVISION, 1941-1970

Climatic Divisions	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
						Degrees Fahrenheit							
East-central	51.1	53.9	59.3	67.7	74.0	79.7	81.5	81.2	77.1	68.0	58.3	52.6	67.0
Southeast	54.3	56.7	61.5	69.3	75.5	80.7	82.2	82.2	78.9	71.0	61.6	56.2	69.2
South-central	52.8	55.4	60.5	69.0	75.1	80.4	81.8	81.8	78.1	69.5	60.1	54.7	68.3

SOURCE: National Weather Service

TABLE C-1-4

PRECIPITATION NORMALS BY CLIMATOLOGICAL DIVISIONS, 1941-1970

Climatic Divisions	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
							Inches						
East-central	4.80	5.24	5.91	4.95	4.88	4.84	6.44	5.14	4.71	2.82	4.11	5.86	59.72
Southeast	4.53	4.80	5.21	4.16	4.48	5.39	7.54	6.30	7.00	2.87	3.79	5.06	61.14
South-central	4.34	4.72	4.58	4.33	4.92	5.39	7.61	6.01	5.69	3.29	3.72	5.10	59.70

SOURCE: National Weather Service; Monthly Averages of Temperatures and Precipitation for State Climatic Divisions 1941-1970; NOAA National Climatic Center; Asheville, NC

PRECIPITATION

C.1.6. The average annual rainfall in the area is approximately 61 inches. The greatest rainfall occurs from June through September. Afternoon convective showers and thunderstorms of short duration frequently occur during this period. The driest month is October. An occasional tropical storm may increase the rainfall amount significantly in the area. The normal rainfall over the land area is displayed in table C-1-4.

C.1.7. Winter rains generally occur when a warm or cold front enters the area. These frontal rains can begin any time of day. They are generally slow and continuous and last for several days. Thunder and strong winds often accompany the rains. Although the amount of winter rainfall is less than that of summer, the incidence of rainfall is greater in the winter. Rain occurs on one-third of the winter days. Snow is extremely rare and usually melts as it falls. The rainfall pattern of spring is similar to that of winter.

C.1.8. In an area with abundant rainfall such as southeast Louisiana, droughts are not often considered to be a significant climatic factor. Drought is relative, however, and rainfall that would be abundant in one region may result in disaster in another. The severity of a drought is often categorized using an index called the Palmer Drought Index. This index is based on the concept that the precipitation needed for nearly normal functioning of the regional economy depends on the long-term climate as well as antecedent and current meteorological conditions. Monthly values for the Palmer Drought Index for the Southeastern Climatic Division of Louisiana are presented in table C-1-5. Since evaporation is much less variable than precipitation and since the area under consideration is largely undrained marsh, drought is defined in this study as 10 percent below normal precipitation continuing through several months. In table C-1-5, below-normal precipitation is apparent from the winter of 1942 through

TABLE C-1-2

CLIMATOLOGICAL DATA SUMMARY FOR BATON ROUGE

Normals, Means, and Extremes

Temperatures °F

Month	Normal: Daily maximum	Normal: Daily minimum	Normal: Monthly	Extremes: Record highest	Year	Extremes: Record lowest	Year
(a)				[illegible]		[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	82	[illegible]	[illegible]	1962
[illegible]	[illegible]	[illegible]	[illegible]	85	[illegible]	[illegible]	1958
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1961	28	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	92	[illegible]	[illegible]	1975
[illegible]	[illegible]	[illegible]	[illegible]	98	1953	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1954	55	1972
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	58	1967
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1962	59	1967
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1961	[illegible]	1967
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1952	[illegible]	1957
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1976
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1978	[illegible]	1962
[illegible]	[illegible]	56.9	67.4	[illegible]	JUN 1954	[illegible]	JAN 1962

Normal Degree days Base 65 °F, and Precipitation in inches

Month	Heating	Cooling	Normal	Water equiv.: Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs	Year	Snow, Ice pellets: Maximum monthly	Year	Maximum in 24 hrs	Year
(a)				29		29		29		29		29	
[illegible]	451	[illegible]	4.40	9.93	1966	1.15	1971	4.08	1975	0.6	1973	0.5	1973
[illegible]	335	24	4.76	14.51	1966	0.70	1962	4.72	1979	1.8	1973	1.8	1973
[illegible]	228	44	5.14	12.73	1973	0.54	1955	6.07	1973	T	1968	T	1968
[illegible]	73	135	5.10	12.64	1967	0.38	1976	12.08	1967	0.0		0.0	
[illegible]	0	304	4.39	10.70	1953	0.63	1963	4.96	1954	0.0		0.0	
[illegible]	0	459	3.77	11.36	1962	0.12	1979	3.96	1962	0.0		0.0	
[illegible]	0	527	6.51	10.98	1961	2.05	1962	4.26	1969	0.0		0.0	
[illegible]	0	515	4.67	13.31	1977	1.42	1951	3.84	1953	0.0		0.0	
[illegible]	0	375	3.79	13.95	1977	0.29	1957	6.31	1973	0.0		0.0	
[illegible]	54	163	2.65	9.46	1964	T	1978	8.38	1964	0.0		0.0	
[illegible]	128	16	3.84	10.35	1977	0.25	1967	4.67	1973	T	1976	T	1976
[illegible]	381	6	5.01	13.23	1953	1.94	1978	4.12	1953	T	1973	T	1973
[illegible]	1670	2585	54.05	14.51	FEB 1966	T	OCT 1978	12.08	APR 1967	1.8	FEB 1973	1.8	FEB 1973

Relative humidity pct., Wind, Sunshine, Sky cover

Month	Hour 00	Hour 06	Hour 12	Hour 18 (Local time)	Mean speed m.p.h.	Prevailing direction	Fastest mile: Speed m.p.h.	Direction	Year	Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
(a)	20	20	20	20	28	12	17	17			28
[illegible]	81	85	66	67	9.3	N	35	23	1975		6.9
[illegible]	78	84	58	60	9.6	NE	35	25	1970		6.7
[illegible]	80	85	57	59	9.7	SE	35	13	1964		6.3
[illegible]	83	89	56	59	9.1	SE	35	25	1964		6.1
[illegible]	84	90	56	60	8.0	SE	46	17	1967		5.7
[illegible]	85	91	58	63	6.8	SE	40	03	1964		5.5
[illegible]	87	91	63	70	6.1	N	35	36	1970		6.4
[illegible]	88	92	63	71	5.7	[illegible]	37	32	1975		5.9
[illegible]	88	91	61	71	6.9	NE	58	06	1965		5.6
[illegible]	85	89	53	65	6.8	NE	40	33	1964		4.3
[illegible]	85	88	58	68	7.9	N	31	33	1977		5.6
[illegible]	82	86	63	69	8.4	SE	30	18	1966		6.3
[illegible]	84	89	59	65	7.9	SE	58	06	SEP 1965		5.9

Mean number of days, and Average station pressure

Month	Sunrise to sunset: Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Ice pellets 1.0 inch or more	Thunderstorms	Heavy fog, visibility ¼ mile or less	Temperatures °F Max (b) 90° and above	Max 32° and below	Min 32° and below	Min 0° and below	Average station pressure mb, Elev. 76 feet m.s.l.
(a)	28	28	28	28	24	28	28	20	20	20	20	7
[illegible]	7	6	18	9	[illegible]	2	5	0	*	10	0	1018.7
[illegible]	8	6	14	9	*	3	[illegible]	0	0	6	0	1017.7
[illegible]	8	9	15	9	[illegible]	4	3	*	0	1	0	1016.1
[illegible]	7	9	14	7	0	5	3	*	0	0	0	1014.7
[illegible]	8	12	11	8	0	6	3	6	0	0	0	1011.9
[illegible]	8	14	8	9	[illegible]	9	1	19	0	0	0	1013.7
[illegible]	4	16	11	14	0	15	[illegible]	24	0	0	0	1014.3
[illegible]	7	14	10	12	[illegible]	12	[illegible]	21	0	0	0	1014.5
[illegible]	9	11	10	9	0	7	3	11	0	0	0	1012.9
[illegible]	15	8	8	5	[illegible]	2	4	2	0	0	0	1016.2
[illegible]	10	8	12	7	0	2	4	0	0	2	0	1017.3
[illegible]	9	6	16	10	0	2	4	0	*	7	0	1017.9
[illegible]	100	118	147	108	*	69	37	82	*	26	0	1015.3

Means and extremes above are from existing and comparable exposures. Annual extremes have been exceeded at [illegible] sites in the [illegible] as follows: Highest temperature 110 in August 1909; lowest temperature 2 in February 1899; maximum monthly precipitation [illegible] in May 1907; minimum monthly precipitation 0.00 in September 1924.

(a) Length of record, years, through the current year unless otherwise noted, based on January data
(b) 70° and above at Alaskan stations
* Less than one half
T Trace

NORMALS - Based on record for the 1941-1970 period.
DATE OF AN EXTREME - The most recent in cases of multiple occurrence.
PREVAILING WIND DIRECTION - Record through 1963.
WIND DIRECTION - Numerals indicate tens of degrees clockwise from true north. 00 indicates calm.
FASTEST MILE WIND - Speed is fastest observed 1-minute value when the direction is in tens of degrees.

STATION: Baton Rouge, Louisiana
POSITION: 30° 32' N 91° 08' W
ELEVATION: 64 feet NGVD

SOURCE: "Local Climatological Data 1979"
NOAA National Climatic Center
Asheville, NC

TABLE C-1-1

CLIMATOLOGICAL DATA SUMMARY FOR NEW ORLEANS

Normals, Means, and Extremes

Month	Temperatures °F – Normal – Daily maximum	Daily minimum	Monthly	Extremes – Record highest	Year	Record lowest	Year	Normal Degree days Base 65 °F – Heating	Cooling
(a)				33		33			
J	62.3	43.5	52.9	83	1957	14	1963	403	28
F	65.1	46.0	55.6	85	1972	19	1970	299	35
M	70.4	50.9	60.7	87	1963	26	1968	188	55
A	78.4	58.8	68.6	91	1948	32	1971	29	137
M	84.9	65.3	75.1	96	1953	41	1960	0	313
J	89.6	71.2	80.4	100	1954	55	1972	0	462
J	90.4	73.3	81.9	99	1951	60	1967	0	524
A	90.6	73.1	81.9	100	1951	60	1968	0	524
S	86.6	69.7	78.2	97	1954	42	1967	0	396
O	79.9	59.6	69.8	92	1977	35	1968	40	189
N	70.3	49.6	60.1	86	1979	24	1970	179	32
D	64.2	45.3	54.8	84	1978	17	1962	327	11
YR	77.1	56.9	68.3	100	JUN 1954	14	JAN 1963	1465	2706

Month	Precipitation in inches – Water equivalent – Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs	Year	Snow, Ice pellets – Maximum monthly	Year	Maximum in 24 hrs	Year
(a)		33		33		33		33		33	
J	4.53	13.63	1978	0.54	1968	6.08	1978	0.1	1973	0.1	1977
F	4.82	12.49	1979	1.02	1962	5.60	1961	2.0	1958	2.0	1958
M	5.49	19.09	1948	0.24	1955	7.87	1948	T	1959	T	1959
A	4.15	10.47	1973	0.28	1976	5.18	1977	0.0		0.0	
M	4.20	14.33	1959	0.99	1949	9.86	1959	0.0		0.0	
J	4.74	12.28	1975	0.23	1979	4.19	1953	0.0		0.0	
J	6.72	11.46	1954	2.91	1977	4.30	1966	0.0		0.0	
A	5.27	16.12	1977	1.69	1976	4.82	1975	0.0		0.0	
S	5.58	16.74	1971	0.24	1953	6.50	1971	0.0		0.0	
O	2.26	6.45	1959	0.00	1978	3.44	1975	0.0		0.0	
N	3.88	14.58	1947	0.21	1949	8.72	1975	T	1950	T	1950
D	5.13	10.77	1967	1.46	1958	4.85	1973	2.7	1963	2.7	1963
YR	56.77	19.09	MAR 1948	0.00	OCT 1978	9.86	MAY 1959	2.7	DEC 1963	2.7	DEC 1963

Month	Relative humidity pct. – Hour 00	Hour 06	Hour 12	Hour 18 (Local time)	Wind – Mean speed m.p.h.	Prevailing direction	Fastest mile – Speed m.p.h.	Direction	Year	Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
(a)	31	31	31	31	31		[illegible]	[illegible]		[illegible]	[illegible]
J	82	85	67	73	9.5		46	[illegible]	1975	45	6.8
F	82	84	63	67	9.9		43	26	[illegible]	59	6.1
M	82	85	61	65	[illegible]		37	18	1964	56	6.3
A	85	88	62	66	9.5		[illegible]	17	[illegible]	65	[illegible]
M	86	89	60	65	8.2		55	[illegible]	1973	59	5.3
J	86	89	62	67	6.9		48	25	[illegible]	66	[illegible]
J	89	91	66	73	6.2		[illegible]	[illegible]	1979	56	[illegible]
A	89	91	65	73	[illegible]		[illegible]	33	1969	55	5.6
S	87	89	66	75	7.3		69	09	1965	58	5.4
O	84	88	59	72	7.5		40	17	1964	[illegible]	4.1
N	84	85	61	74	8.7		30	31	1969	57	5.1
D	83	85	66	75	9.1		46	28	1973	56	6.2
YR	85	88	63	70	8.3		69	09	SEP 1965	59	[illegible]

Month	Mean number of days – Sunrise to sunset – Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Ice pellets 1.0 inch or more	Thunderstorms	Heavy fog visibility 1/4 mile or less	Temperatures °F – Max – 90° and above (b)	Max – 32° and below	Min – 32° and below	Min – 0° and below	Average station pressure mb.
(a)	31	31	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	33	33	[illegible]	[illegible]	
J	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2	[illegible]	[illegible]	*	[illegible]	[illegible]	[illegible]
F	8	7	[illegible]	9	*	3	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
M	8	8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
A	8	[illegible]	[illegible]	[illegible]	[illegible]	6	[illegible]	*	[illegible]	*	[illegible]	[illegible]
M	[illegible]	[illegible]	[illegible]	*	[illegible]	6	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
J	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9	*	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
J	5	15	[illegible]	15	[illegible]	[illegible]	*	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
A	8	[illegible]	9	[illegible]	[illegible]	[illegible]	*	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
S	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	*	8	[illegible]	[illegible]	[illegible]	[illegible]
O	[illegible]	8	[illegible]	5	[illegible]	2	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
N	[illegible]	9	[illegible]	[illegible]	[illegible]	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
D	8	8	[illegible]	[illegible]	*	2	[illegible]	[illegible]	*	*	[illegible]	[illegible]
YR	109	[illegible]	[illegible]	[illegible]	*	69	[illegible]	69	*	[illegible]	[illegible]	[illegible]

Means and extremes above are from existing and comparable exposures. Annual extremes have been exceeded at other sites in the locality as follows: Highest temperature 102 in June 1954 and earlier (City Office); lowest temperature 7 in February 1899; maximum monthly precipitation 25.11 in October 1937; maximum precipitation in 24 hours 14.01 in April 1927; maximum monthly snowfall 8.2 in February 1895; maximum snowfall in 24 hours 8.2 in February 1895.

(a) Length of record, years, through the current year unless otherwise noted, based on January data.
(b) 70° and above at Alaskan stations.
* Less than one half.
T Trace.

NORMALS - Based on record for the 1941-1970 period.
DATE OF AN EXTREME - The most recent in cases of multiple occurrence.
PREVAILING WIND DIRECTION - Record through 1963.
WIND DIRECTION - Numerals indicate tens of degrees clockwise from true north. 00 indicates calm.
FASTEST MILE WIND - Speed is fastest observed 1-minute value when the direction is in tens of degrees.

STATION: New Orleans, Louisiana
POSITION: 29°59'N 90° 15' W
ELEVATION: 4 feet NGVD

SOURCE: "Local Climatological Data 1979"
NOAA National Climatic Center
Asheville, NC

TEMPERATURE

C.1.3. Temperatures are influenced by warm gulf waters. Average annual water temperature is 76°F. Monthly water temperatures range from 65°F in February to 84°F in August. Monthly air temperatures are a close parallel to water temperatures and range from 61°F in January to 84°F in August. Except in summer, surface waters are warmer than the overlying air, on the average. The moderating influence of gulf waters reduces daytime and annual ranges in air temperatures.

C.1.4. Extreme changes in the study area air temperatures occur when continental hot or cold air masses penetrate the area. Low temperatures are associated with high pressure systems. These cold air masses are quickly tempered by the gulf climate. This action is apparent when air temperatures over land are compared with air temperatures offshore. Freezing temperatures have been recorded in New Orleans from November through April, and at Baton Rouge, just north of the upper study limits, from October to March (tables C-1-1 and C-1-2, respectively). In the offshore area, freezing temperatures have been recorded only for January and February. High temperatures are associated with hot continental air that invades the area, usually in July and August. Normal land air temperatures vary less than one degree in the eastern and western portions of the area throughout most of the year. In December, January, and February, however, this difference increases slightly to 1.5 degrees.

C.1.5. Regional temperature normals are presented in table C-1-3 for the east-central, southeast, and south-central climatological divisions of Louisiana. Data from the southeast climatological division is pertinent to the study. The other two divisions are listed for comparison.

Section 1. HYDRAULIC AND HYDROLOGY SURVEY

GENERAL

C.1.1. The hydraulic and hydrologic studies are based on office studies and a review of available information. Climatological and hydrological data were analyzed to document existing conditions and historical salinity changes. To predict future salinity changes, prior studies conducted by Gagliano et al. (1970 a and b, and 1973) and the US Army Corps of Engineers (1970) were reviewed and their methodologies refined. In the analysis, salinities were correlated with the availability of freshwater. This relationship was used to estimate the supplemental flows required to establish optimal salinity conditions. The optimum locations for introducing supplemental flows were determined through a hydraulic analysis of 21 potential diversion sites. Based on preliminary engineering, environmental, and institutional studies, six sites were selected for detailed hydraulic studies and detailed hydraulic designs were prepared.

CLIMATOLOGY

C.1.2. The climate of the area is humid, sub-tropical, and strongly influenced by the Gulf of Mexico. Throughout the year, warm, moist air from the gulf modifies the relative humidity and temperature conditions over the marshes, and decreases the range between hot and cold temperature extremes. When southerly winds prevail, the maritime effects are increased. Frequently, extended periods of stable humidity and temperature occur. During winter, the climate alternates between cold continental air and tropical air. Prevailing winds in summer transport warm, moist air northward providing favorable conditions for thunderstorms. Summer is also the principal season for occasional tropical storms or hurricanes.

LOUISIANA COASTAL AREA

Interim Report on Freshwater Diversion

to

Barataria and Breton Sound Basins

APPENDIX C

E N G I N E E R I N G   I N V E S T I G A T I O N S

C.0.1. Engineering investigations were conducted to determine hydraulic and hydrologic conditions in the study area and historical changes in salinity. Based on the existing and historical conditions, future salinity changes were projected. From the projected changes, supplemental freshwater quantities required to obtain desirable salinity conditions were determined. Studies were then conducted to identify possible diversion sites, the hydraulic characteristics of diversion structures and channels, and the geology and soils conditions at the sites. Finally, detailed designs and cost estimates were prepared.

LIST OF PLATES (CONT'D)

LIST OF PLATES

LIST OF TABLES (CONT'D)

LIST OF TABLES (CONT'D)

LIST OF TABLES (CONT'D)

TABLE C-1-6

PERCENTAGE OF WIND DIRECTIONS

Louisiana Offshore Area

Direction/Months	J	F	M	A	M	J	J	A	S	O	N	D
N	19	13	12	10	10	4	4	4	6	13	18	12
NE	16	20	13	18	16	10	10	11	22	34	23	18
E	21	21	20	32	28	30	28	22	33	28	24	22
SE	17	17	27	19	17	23	18	13	13	7	11	16
S	7	10	12	7	6	6	10	8	5	2	6	8
SW	5	3	3	2	3	4	5	7	2	2	2	3
W	5	6	4	4	4	2	6	3	2	2	3	5
NW	10	10	7	7	5	4	4	5	4	4	7	7

Source: Stone 1972

NOTE: Some total monthly percentages do not equal 100 due to periods of no wind.

EVAPORATION

C.1.12. Evaporation data for the Louisiana coastal area is limited to only intermittent periods of record at several stations, none of which are in the study area. Four incomplete years of evaporation data are available from the Houma US Sugarcane Field Station, adjacent to the western boundary of the area. The Houma station is considered representative of the study area because of similar proximity to the gulf coast. Using the Houma station data, the unadjusted annual evaporation in the Barataria Basin (study area west of the Mississippi River) was estimated at 57 inches. Applying the pan coefficient for this region, the annual evaporation rate of 43.3 inches was computed.

C.1.13. More than 10 continuous years of evaporation data are available from the Louisiana State University Ben Hur Experimental Farm Station, Baton Rouge, Louisiana. This station is adjacent to the upper limits of the study area. Data covering the period from 1963-1972, presented in table C-1-7, shows an adjusted average annual evaporation of 44.7 inches.

C.1.14. Comparing each station's monthly evaporation totals for matching periods of record indicated a higher evaporation rate at the Baton Rouge station (table C-1-8). The average annual difference between the two stations was 6.67 inches. This difference is probably explained by higher humidities, greater sky cover, and lower wind stress at the Houma location.

HYDROLOGY

C.1.15. Barataria Basin and Breton Sound area were investigated in this study. The subsections, "Freshwater Runoff and Streamflow," "Tides," and "Circulation," discuss the entire study area. The remaining subsection discusses Barataria Basin and Breton Sound separately.

FRESHWATER RUNOFF AND STREAMFLOW

C.1.16. Direct rainfall into the marsh area is supplemented by rainfall runoff from developed areas along the high banks of the Mississippi River, Bayou Lafourche, and many smaller bayous. Rainfall within the leveed areas is pumped out by low lift pumps into smaller bayous in the swamps. The Mississippi River, which forms the northeastern study boundary, is another source of freshwater entering the marsh area, though it is almost completely confined by high flood protection levees. On the west bank (Barataria Basin area) of the Mississippi River near Donaldsonville approximately 1000 cfs of water is pumped into Bayou Lafourche. Smaller quantities enter the area via Port Allen, Harvey, and Algiers Locks. Further southward, near the small town of Caernarvon, the Mississippi River divides the area. On the east bank

TABLE C-1-7

ADJUSTED CLASS A PAN EVAPORATION 1/

LSU Ben Hur Experimental Farm, 1963-1972

Measured In Inches

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1963	---	---	4.3	5.6	6.9	5.5	4.8	5.1	3.9	4.1	2.3	1.4	47.8
1964	1.4	2.5	3.3	4.0	6.1	5.5	3.8	4.3	4.4	3.3	2.7	1.7	43.2
1965	1.6	2.2	3.3	4.9	5.0	5.9	5.3	4.5	4.6	4.2	2.8	2.1	46.4
1966	1.4	2.0	3.7	5.1	4.9	6.5	4.3	4.0	3.6	3.3	2.7	1.6	43.2
1967	1.6	1.9	4.0	5.4	5.2	5.4	4.2	4.3	3.8	4.0	2.7	1.4	43.7
1968	1.5	2.4	3.3	4.1	5.2	5.8	5.2	5.5	4.4	4.2	2.1	1.7	45.3
1969	2.1	1.7	2.2	4.0	4.2	5.8	4.1	4.6	4.3	3.4	2.1	1.4	40.4
1970	1.1	2.6	3.2	4.5	5.5	5.8	5.1	4.2	3.6	3.2	2.3	1.9	42.9
1971	1.7	2.8	3.4	4.7	6.2	5.5	5.3	4.7	3.1	3.3	2.6	0.9	44.2
1972	1.7	2.5	4.0	5.8	5.7	6.6	4.8	5.4	4.0	3.7	2.2	2.1	48.5
Mean	1.6	2.3	3.5	4.8	5.5	5.8	4.7	4.7	4.0	3.7	2.5	1.6	44.7

SOURCE: "Variation in the Response Of the Evaporation Rate To the Active Factors Of Weather and Climate: LSU Ben Hur Experimental Farm, Baton Rouge, Louisiana" a master's thesis by R.H.W. Cunningham.

1/ Raw pan EV data has been adjusted by the use of a 0.76 pan coefficient.

TABLE C-1-8

TOTAL EVAPORATION

Houma Versus Baton Rouge

YEAR	STA.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual[a]
1976	Houma	--	--	--	--	--	--	--	--	--	--	2.93b	1.77b	4.70a
	Baton Rouge	--	--	--	--	--	--	--	--	--	--	3.69b	2.89b	6.58a
1977	Houma	--	--	--	--	7.55b	7.28b	6.79b	4.69b	5.56b	4.34b	2.87b	3.01b	42.09
	Baton Rouge	--	--	--	--	7.77	8.38	8.92	6.29	5.88	5.17	3.49	3.75	49.65
1978	Houma	--	2.71b	4.21b	5.91b	6.98b	7.84b	6.65b	8.51b	5.52b	5.36	3.55b	2.80b	60.04
	Baton Rouge	--	3.34b	4.61	7.16b	6.76	7.30	7.34	7.73	5.21	6.61	3.66	2.86b	62.58
1979	Houma	--	2.59b	5.65	5.56b	7.19b	7.06b	6.84b	5.63b	5.33	4.90	3.20	2.24b	49.35c
	Baton Rouge	--	3.30b	5.57	5.65b	7.37	8.08	--	6.88	6.17	6.64	4.47	2.41	56.27
Mean	Houma	--	2.65	4.93	5.74	7.24	7.39	6.76	5.28	5.47	4.87	3.14	2.46	56.93
	Baton Rouge	--	3.19	4.99	6.40	7.30	7.92	8.13	6.97	5.75	6.14	3.83	2.98	63.60

[a]Not a full year

[b]Adjusted to a full month

--No record

[c]Number of months accumulated for total made equal for both stations

(Breton Sound area) of the Mississippi River, freshwater enters the adjacent marsh areas at White's Ditch through a 100-cfs siphon, at Bohemia through a 2,500- cfs box culvert, and at Bayou Lamoque through 4,500-cfs and 6,500-cfs box culvert structures.

C.1.17. Streamflow measurements in the coastal zone are practically non-existent, except for the Mississippi River, largely because of tidal influences. As a result of the lack of streamflow data, it was necessary to hypothetically compute the water yield (moisture surplus) in the study area. In a previous study of the coastal zone conducted by the Louisiana State University Center for Wetlands, the water yield was computed using the Thornwaite-Mather Water Balance Model. The results of that study are discussed in the following paragraphs.

C.1.18. The Center for Wetlands study, "Hydrologic and Geologic Study of the Louisiana Coastal Area" (Gagliano et al., 1970 b and f), showed considerable variation in the seasonal and annual water yield in the coastal region from 1945 to 1968. Water yield methodology identifies either a surplus or a deficit. Water surpluses, which occur when precipitation exceeds potential evaporation and soil moisture storage, were found to be most common during the winter-spring (December through May) period. Water deficits, which occur when precipitation is exceeded by potential evaporation and soil moisture, were found to usually occur during the summer-fall (June through November) period. Table C-1-9 shows the cumulative frequency, by percentage, that the seasonal surpluses and annual deficits equalled or exceeded for a given value in inches at the climatic division normal stations for the period 1945-1968. The average annual water yield for the period was calculated as 800 cfs in Breton Sound and 2,600 cfs in Barataria Basin. Analysis of the monthly and annual water yields computed using the Thornwaite-Mather Water Balance Model shows that 1961 and 1963 were among the wettest and driest years. Table C-1-10 presents the computed water yields for 1961 and 1963.

TABLE C-1-9

WATER SURPLUS AND DEFICITS

Percentage frequency seasonal water surplus (S) and annual deficits (D) equalled or exceeded given value in inches, 1945-1968

Climatologic Division	Winter-Spring				Summer-Fall			Annual			
	S≥ 40"	S≥ 30"	S≥ 20"	S≥ 10"	S≥ 10"	S≥ 2"	S≥ 0"	D≥ 15"	D≥ 10"	D≥ 5"	D≥ 2"
	Percent										
East-Central											
Franklinton	4	22	65	96	29	50	67	0	0	25	67
Bogalusa	0	17	57	96	8	46	54	0	8	25	67
Covington	4	17	57	91	17	50	54	0	0	25	71
Baton Rouge	0	0	30	87	0	30	61	0	8	58	83
Southeast											
Donaldsonville	0	0	26	96	4	58	75	0	4	33	67
Reserve	0	4	26	88	12	50	67	0	12	46	67
New Orleans	0	13	39	83	12	54	62	0	0	25	62
Paradis	0	13	35	83	25	54	71	0	0	29	75
Houma	0	9	30	87	38	79	79	0	0	12	62
Buras	0	0	22	78	38	83	96	0	8	17	50

Source: Gagliano et al. (1970b)

TABLE C-1-10

ESTIMATED WATER YIELD FOR 1961 AND 1963 1/

Areas	Winter 1961	Winter 1963	Spring 1961	Spring 1963	Summer 1961	Summer 1963	Autumn 1961	Autumn 1963	Annual 1961	Annual 1963
					(1000 cfs)					
Breton Sound	2.3	1.7	1.4	-1.4	0.9	2/	0.8	0.9	1.5	0.5
Barataria Basin	13.0	7.9	7.2	-5.0	4.5	-1.0	5.2	4.9	8.1	2.3

SOURCE: Gagliano, et al. (1970 f)

1/ Surpluses indicated by positive numbers
Deficiencies indicated by negative numbers

2/ Less than 50 cfs.

C.1.19. The 1961 water yield was approximately two times the mean annual yield in Breton Sound and three times that in Barataria Basin for the period 1945-1968 (Gagliano et al., 1970 f). During the winter and spring season of 1961, the water yield was 3.65 and 3.62 cfs per square mile in Breton Sound and Barataria Basin, respectively. In 1963, the water yield ranged only between 60 and 90 percent of the mean annual yield. The largest deficiencies occurred in the spring, although some deficiencies occurred in Barataria Basin during the summer. These two years are representative of extreme wet and dry conditions in the marshes and were used, as will be discussed later, along with other criteria in developing water needs for managing the estuary.

TIDES

C.1.20. The range, character, timing, and extent of the tides in the study area and the level of the gulf from which they rise and fall varies with the meterological conditions, physical configuration of the water bottom and shorelines, and seasonal freshwater runoff. The tides are generally of the diurnal type, that is, one high and one low water each day. The normal range of the spring tides along the coast is between 1 and 2 feet. Tidal influences extend upstream above the latitude of Thibodaux, Des Allemands, and New Orleans, and vary at these sites from almost zero to 0.8 foot depending on the cross-section of the stream involved and its discharge.

C.1.21. In the study area, the average elevation of the marsh is slightly less than +1 foot National Geodetic Vertical Datum (NGVD) (Nichols, 1959, and Chabreck, 1972). During the summer and autumn months when the level of the gulf is highest, water floods the marsh to average depths of 0.2 feet. The water tends to remain there during the season because of prolonged southerly winds and high tides. The distance water is driven inland and the rise in water levels depend on the duration and velocity of the winds, marsh elevation, and distance from the gulf. Tropical storms and hurricanes have produced tides in excess of 12 feet NGVD along the coast and have raised levels significantly far inland. Monthly average tide data for the gages at Grand Isle (coastal area) and Des Allemands (inland area) are presented in tables C-1-11 and C-1-12.

TABLE C-1-11

MONTHLY MEAN STAGES

Bayou Rigaud-Grand Isle, LA.

Stages in Feet (NGVD)

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1964	-0.6	-0.4	0.1	0.4	0.9	0.8	0.7	0.9	1.1	1.3	0.3	0.0
1965	-0.2	0.0	-0.1	0.5	0.9	1.1	0.9	1.0	1.8	0.9	1.2	0.6
1966	0.2	0.0	0.3	0.6	1.2	1.0	1.0	0.9	1.0	0.7	0.1	-0.1
1967	-0.1	0.0	0.2	0.8	0.9	1.4	1.1	1.2	1.2	0.9	0.4	0.1
1968	-0.1	0.0	0.1	0.8	0.9	1.0	1.1	1.1	1.2	1.1	0.1	0.1
1969	-0.1	0.3	0.4	0.9	1.2	1.3	1.1	1.2	1.1	1.2	0.2	0.0
1970	-0.2	-0.2	0.6	1.1	1.5	1.5	1.4	1.5	1.5	1.4	0.5	0.3
1971	0.3	0.3	0.5	0.9	1.1	1.0	1.2	1.2	1.6	1.3	0.8	0.7
1972	0.5	0.2	0.6	0.9	1.3	1.3	1.4	1.1	1.6	1.5	0.7	0.6
1973	0.6	0.5	1.1	1.2	1.1	1.1	1.4	1.4	1.7	1.4	1.1	0.5
1974	0.6	0.5	0.9	1.5	1.9	1.8	1.5	1.5	1.7	1.3	0.7	0.3
1975	0.5	0.9	1.2	1.5	1.8	1.8	1.7	1.7	1.9	1.2	1.0	0.7
1976	0.1	0.2	0.9	1.0	1.0	1.3	1.0	0.9	0.9	0.8	0.2	0.3
1977	-0.2	-0.1	0.5	0.9	1.3	1.2	1.1	1.7	1.9	1.1	1.0	0.5
1978	0.3	0.3	0.6	1.2	1.7	1.7	1.5	1.5	1.7	1.3	1.0	0.6
1979	0.3	0.5	1.0	1.8	1.8	1.7	1.9	1.8	2.1	1.3	0.9	0.5
MEAN	0.1	0.2	0.6	1.0	1.3	1.3	1.3	1.3	1.5	1.2	.6	.4

TABLE C-1-12

MONTHLY MEAN STAGES

Bayou Des Allemands @ Des Allemands, LA.

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				Stages in Feet (NCVD)								
1964	0.3	0.2	0.9	0.9	1.0	0.6	0.6	0.8	0.8	0.9	0.7	0.5
1965	0.7	0.7	0.3	0.7	0.8	0.8	0.5	0.8	1.5	1.2	1.0	0.9
1966	1.0	1.0	1.0	0.9	1.6	0.9	0.7	0.7	0.9	0.8	0.6	0.4
1967	0.5	0.7	0.5	1.1	1.1	1.2	0.8	1.0	1.3	0.7	0.8	1.1
1968	0.6	0.3	[illegible]	1.0	1.0	0.7	0.8	0.9	1.1	0.9	0.4	0.5
1969	0.5	0.7	0.9	1.0	1.1	0.8	0.7	0.9	0.8	1.1	0.6	0.4
1970	0.2	0.3	0.8	1.1	1.3	1.1	0.8	1.1	1.4	1.6	0.6	0.7
1971	0.5	0.7	0.7	0.7	0.9	0.5	0.7	0.8	1.8	1.3	1.1	1.4
1972	[illegible]	0.9	1.0	0.9	1.5	1.3	1.3	0.9	1.4	1.6	1.6	1.0
1973	1.0	0.9	1.7	2.2	1.7	1.3	0.8	1.0	1.9	1.7	1.5	1.0
1974	1.4	1.2	1.1	1.7	1.8	1.5	1.0	1.2	1.6	1.4	1.3	1.0
1975	1.0	1.2	1.0	1.0	1.8	2.0	1.5	1.4	1.8	1.3	1.5	1.0
1976	0.6	0.7	1.1	1.2	0.8	1.4	1.0	0.9	1.1	0.7	0.6	0.8
1977	0.6	0.5	1.1	1.6	1.1	1.2	1.1	1.5	2.9	1.5	1.5	1.2
1978	1.1	0.8	0.8	1.3	0.9	1.2	1.1	1.3	1.6	1.3	1.4	1.2
1979	0.7	1.3	1.4	2.0	1.8	1.5	1.6	1.5	1.6	1.2	1.1	0.8
MEAN	0.7	0.8	0.9	1.2	1.3	1.1	0.9	1.0	1.5	1.2	1.0	0.9

CIRCULATION

C.1.22. The surface currents flowing northwest induce the current pattern off the Louisiana coast. As these currents move across the continental shelf inshore toward the Mississippi Delta, they divide into eastern and western components. The eastern current flows north and east of the Chandeleur Islands. The western current parallels the coastline. The pattern of surface currents is shown on plate C-1.

C.1.23. East of the Mississippi River, the littoral drift is generally north and east into Breton and Chandeleur Sounds. Off the Mississippi Delta, littoral currents generally flow westward except for a small circular current east of South Pass. Immediately west of the delta, the littoral drift is northwest and north to the Bayou Lafourche area where it curves eastward to the delta in a clockwise pattern. In the vicinity of Timbalier Bay, the littoral drift is generally east to northeast following the shoreline. Westward of this area, the littoral drift parallels the shoreline.

C.1.24. Within the estuarine water bodies, the water circulation pattern depends on the hydraulic gradient produced by tidal action at the mouth of the estuaries and freshwater inflows at the stream heads. The wind also modifies the circulation pattern. Northerly winds push the water out of the marsh, while southerly winds drive the water into the estuaries.

C.1.25. In the offshore area, current velocities average between 0.4 and 0.6 knots. Littoral current velocities increase slightly, averaging between 0.7 to 1.0 knots. The current velocities are generally faster in the spring and summer than in the autumn and winter. Current velocities in the major waterways normally vary from 0.1 to 2.5 knots, but are greater during high water discharges.

HISTORICAL SALINITY CHANGES

C.1.26. Authorities have recognized that greater saltwater encroachment is occurring in Louisiana estuaries. The encroachment has been observed largely through changes in vegetation patterns and types and, to a lesser degree, through salinity data. Historical salinity data covering the coastal area of Louisiana have not fully displayed the magnitude of the changing salinity levels because of a lack of actual data and the spottiness of the data that are available. In this study, several salinity monitoring stations were analyzed (see plate C-2 for salinity station locations) over a period of record that ranged from 10 years to 23 years. In tables C-1-13, C-1-14, C-1-15, and C-1-16, respectively, average monthly salinities for an offshore platform site in the Gulf of Mexico off Grand Isle, Grand Terre Slip on Barataria Bay, St. Mary's Point, and Lafitte on Bayou Barataria are presented. Mean salinity values for varying periods of record are also presented.

C.1.27. To study the salinity data, plots of monthly mean values were displayed for each station (plates C-3 and C-4). The Lafitte and St. Mary's Point data for 1956-1963 indicated little response to gulf influences. However, the salinity patterns for Lafitte and St. Mary's Point increased for virtually all months for the period 1964-1979 as compared to the period 1956-1963. This increase can be attributed partly to the completion of the Barataria Bay Waterway in 1963, which provided a major access for saline water to enter the estuary. The Barataria Bay Waterway is not unique in its influence on salinities. Between the period 1940-1970 approximately 71.2 square miles of canals and channels were dredged in Barataria Basin and 12.9 square miles in Breton Sound Basin (Gagliano et al., 1973). The tidal shoreline has been lengthened by 1,551 miles and 561 miles in Barataria and Breton Sound Basins, respectively (Becker, 1972). The annual salinity highs for St. Mary's Point, Grand Terre Slip, and the Offshore Platform stations occurred progressively in October, November, and December, respectively. The

TABLE C-1-13

MONTHLY MEAN SALINITIES FOR THE GULF OF MEXICO

Grand Isle Offshore Platform

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1960			26.9	23.7	23.4	24.1	25.9	25.2	24.7	26.7	28.6	30.3
1961	30.6	29.4	24.1	24.0	18.9	14.3	20.4	22.9	25.3	25.7	27.7	26.4
1962	25.9	21.8	25.3	20.0	19.0	20.3	26.1	26.4	26.6	27.9	29.3	29.7
1963	30.5	30.5	26.6	21.5	26.6	26.7	29.3	29.9	28.3	29.6	31.0	31.7
1964	31.9	31.2	26.8	17.8	15.9	16.7	25.5	26.6	27.9	29.8	28.8	29.0
1965	26.9	28.1	26.1	17.0	19.2	21.3	26.1	26.7	27.0	26.8	27.4	29.2
1966	27.6	25.7	21.7	26.6	22.9	22.7	26.0	27.1	27.2	28.7	29.1	29.0
1967	27.7	28.1	26.8	19.1	25.2	21.8	26.4	26.5	25.7	28.3	28.5	28.1
1968	25.8	26.5	27.6	17.1	20.5	18.8	22.0	22.9	25.2	27.5	29.6	29.2
1969	27.2	25.4	25.7	22.9	18.4	20.6	26.5	25.3	25.7	27.1	28.7	30.4
MEAN												
'61-'69	28.2	27.4	25.6	20.7	20.7	20.4	25.4	26.0	26.5	27.9	28.9	29.2

TABLE C-1-14

MONTHLY MEAN SALINITIES FOR BARATARIA BAY

Grand Terre Slip

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1959		21.0	22.7	21.9								
1960												
1961				24.1	16.9	11.4	14.7	17.3	18.7	21.8	26.2	
1962	21.1	20.6	21.3	18.7	15.6	17.4	23.4	26.4	23.9	29.5	29.5	29.0
1963	29.6	29.3	26.8	21.9	25.7	24.0	25.3	23.3	27.1	30.2	25.6	21.0
1964	25.2	24.5	23.6	15.7	14.7	16.6	19.5	25.0	27.5	26.0	27.1	25.9
1965	23.8	24.1	21.8	16.5	14.6	14.4	24.9	24.1	24.0	24.2	27.2	24.5
1966	21.7	20.9	16.7	23.4	17.2	17.7	22.9	16.6	21.9	24.9	28.6	21.6
1967	17.6	18.1	20.4	18.2	23.7	29.4	23.0	25.2	22.3	25.6	26.6	24.6
1968	22.1	24.7	26.1	16.6	17.7	18.3	19.5	19.6	24.3	27.9	29.7	27.2
1969	27.0	25.5	22.4	20.6	14.5	18.2	22.1	20.2	23.3	28.2	30.7	29.2
1970	23.8	26.6	24.2	20.6	14.9	18.2	20.4	21.9	20.6	22.3	23.8	22.5
1971	23.1	24.7	21.6	19.8	22.7	22.8	26.0	21.4	15.7	16.4	23.7	25.9
1972	20.5	21.7	20.6	21.8	20.3	21.2	25.5	25,3	26.6	29.3	25.3	21.8
1973	16.5	19.2	17.1	12.2	14.9	13.7	21.7	13.5	24.1	25.9	28.5	28.1
1974	15.4	13.2	16.4	13.1	15.3	15.7	19.9	23.7	21.6	30.9	29.5	26.0
1975	22.5	16.1	19.5	16.3	7.9	11.4	18.3	17.2	18.4	22.4	23.2	27.1
1976	27.8	23.2	22.7	18.8	24.0	21.5	24.1	24.5	24.4	29.1	25.9	24.6
1977	27.3	26.6	22.5	18.9	16.1	23.4	22.7	21.8	18.9	22.0	22.8	22.4
1978	20.1	22.5	21.9	13.9	15.4	14.3	21.1	18.5	16.8	22.1	24.3	24.2
MEAN '62-78	22.7	22.4	21.5	18.4	17.4	18.1	22.4	21.7	22.4	25.7	26.6	25.0

C.1.44. For each of the seven subbasins, the water balance was computed using input control data from table C-1-23.

TABLE C-1-23

SOIL MOISTURE STORAGE FOR SUBBASINS IN BARATARIA BASIN

Subbasins	Area(mi^2)	Station	Station Weight	Soil Moisture Storage(mm) (upper soil/lower soil)
I	268	Donaldsonville	60	20/37
		Reserve	10	20/37
		Schreiver	30	20/37
II	113	Paradis	20	10/30
		Schreiver	80	10/30
III	39	Paradis	100	-
IV	158	Paradis	35	15/35
		Reserve	65	15/35
V	29	Paradis	50	-
		Schreiver	50	-
VI	394	Paradis	50	-
		New Orleans	50	-
VII	1014	Galliano	40	-
		Diamond	60	-

C.1.45. Soil moisture storage was estimated for subbasins I, II, and IV based on the percentage of poorly drained marsh and well drained marsh. The remaining subbasins are poorly drained and will not dry out. Thus, these subbasins have infinite moisture storage. Moisture surplus for these marsh areas was then computed on the basis of P-PE with soil moisture storage not considered. Monthly mean moisture surplus is presented for the combined subbasins I-VI and I-VII in tables C-1-24 and C-1-25, respectively.

C.1.46. Monthly water budget components were computed for each subbasin unit for the period 1950-1979. A runoff lag factor was applied to each

during summer. The Des Allemands stage variations are less pronounced than those of Grand Isle. Des Allemands stages tend to be higher than average in the spring in response to warm air movements from the gulf, then dip slightly in July and August, and rise to highest levels in September when gulf tropical disturbances are most common. The lowest Des Allemands stages usually occur in December.

C.1.42. Basin Moisture Surplus. The moisture surplus of the basin had to be determined for use in the correlation analyses. Moisture surplus was determined on a monthly mean basis by using a modified version of the Thornthwaite-Mather Water Balance Model. Since the 1972 Gagliano study, which used the Thornthwaite Model to determine moisture surplus, the model was modified to provide the following additional features:

- Monthly pan evaporation (PE) coefficients.
  Monthly PE coefficients are ratios used to adjust daily values of the calculated model PE to values more representative of the area.

- Two-layer soil moisture system and rainfall intensity factor. The soil moisture zone is divided into upper and lower zones. Moisture content in the upper zones is much more affected by individual events. The lower zones are affected less frequently and only after the upper zones are completely saturated or the moisture content is depleted.

- Synthesis of surplus.
  The modified water budget model calculated surplus or runoff for a watershed with multiple data stations (temperature and precipitation) and multiple land uses or surface moisture conditions (well-drained uplands or wetlands).

C.1.43. In the current analysis, the period of record of the basic data used was increased from 1945-1968 to 1950-1979. The Barataria Basin was subdivided to permit a closer representation of existing conditions (see plate C-2). The potential evaporation computation in the water balance model was adjusted based on the observed monthly pan coefficients at the LSU Ben Hur station. The Ben Hur station was selected over the Houma station because a longer continuous period of record was available.

TABLE C-1-22

THREE-MONTH AVERAGE STAGES

Bayou des Allemands at des Allemands, Louisiana

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1964	0.4	0.2	0.5	0.7	0.9	0.8	0.7	0.7	0.7	0.8	0.8	0.7
1965	0.6	0.6	0.6	0.6	0.6	0.8	0.7	0.7	0.9	1.2	1.2	1.0
1966	1.0	1.0	1.0	1.0	1.2	1.1	1.1	0.8	0.8	0.8	0.8	0.6
1967	0.5	0.5	0.6	0.8	0.9	1.1	1.0	1.0	1.0	1.0	0.9	0.9
1968	0.8	0.7	0.4	0.6	0.8	0.9	0.8	0.8	0.9	1.0	0.8	0.6
1969	0.5	0.6	0.7	0.9	1.0	1.0	0.9	0.8	0.8	0.9	0.8	0.7
1970	0.4	0.3	0.4	0.7	1.1	1.1	1.0	0.9	1.1	1.4	1.2	1.0
1971	0.6	0.6	0.6	0.7	0.8	0.7	0.7	0.7	1.1	1.3	1.4	1.3
1972	1.2	1.2	1.0	0.9	1.1	1.2	1.4	1.2	1.2	1.3	1.5	1.4
1973	1.2	1.0	1.2	1.6	1.9	1.7	1.3	1.0	1.2	1.5	1.7	1.4
1974	1.3	1.2	1.2	1.3	1.5	1.7	1.4	1.2	1.3	1.4	1.4	1.2
1975	1.1	1.1	1.1	1.1	1.3	1.6	1.8	1.6	1.6	1.5	1.5	1.3
1976	1.0	0.8	0.8	1.0	1.0	1.1	1.1	1.1	1.0	0.9	0.8	0.7
1977	0.7	0.6	0.7	1.1	1.3	1.3	1.1	1.3	1.7	1.8	1.8	1.4
1978	1.3	1.0	0.9	1.0	1.0	1.1	1.1	1.2	1.3	1.4	1.4	1.3
1979	1.1	1.1	1.1	1.6	1.7	1.8	1.6	1.5	1.6	1.4	1.3	1.0
MEAN	0.9	0.8	0.8	1.0	1.1	1.2	1.1	1.0	1.1	1.2	1.2	1.0

TABLE C-1-21

THREE MONTH AVERAGE STAGES

Bayou Rigaud @ Grand Isle, LA

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1964	-0.3	-0.5	-0.3	0.0	0.5	0.7	0.8	0.8	0.9	1.1	0.9	0.5
1965	0.0	-0.1	-0.1	0.1	0.4	0.8	1.0	1.0	1.2	1.2	1.3	0.9
1966	0.7	0.3	0.2	0.3	0.7	0.9	1.1	1.0	1.0	0.9	0.9	0.6
1967	0.3	-0.1	0.0	0.3	0.6	1.0	1.1	1.2	1.2	1.1	0.8	0.5
1968	0.1	0.0	0.0	0.3	0.6	0.9	1.0	1.1	1.1	1.1	0.8	0.4
1969	0.0	0.1	0.2	0.5	0.8	1.1	1.2	1.2	1.1	1.2	0.8	0.5
1970	0.0	-0.1	0.1	0.5	1.1	1.4	1.5	1.5	1.5	1.5	1.1	0.7
1971	0.4	0.3	0.4	0.6	0.8	1.0	1.1	1.1	1.3	1.4	1.2	0.9
1972	0.7	0.5	0.4	0.6	0.9	1.2	1.3	1.3	1.4	1.4	1.3	0.9
1973	0.6	0.6	0.7	0.9	1.1	1.1	1.2	1.3	1.5	1.5	1.4	1.0
1974	0.7	0.5	0.7	1.0	1.4	1.7	1.7	1.6	1.6	1.5	1.2	0.8
1975	0.5	0.6	0.9	1.2	1.5	1.7	1.8	1.7	1.8	1.6	1.4	1.0
1976	0.6	0.3	0.4	0.7	1.0	1.1	1.1	1.1	0.9	0.9	0.6	0.4
1977	0.1	0.0	0.1	0.4	0.9	1.1	1.2	1.3	1.6	1.6	1.3	0.9
1978	0.6	0.4	0.4	0.7	1.2	1.5	1.6	1.6	1.6	1.5	1.3	1.0
1979	0.6	0.5	0.6	1.1	1.5	1.8	1.8	1.8	1.9	1.7	1.4	0.9
MEAN	0.4	0.2	0.3	0.6	0.9	1.2	1.3	1.3	1.4	1.3	1.1	0.7

TABLE C-1-20

3 MONTH AVERAGE DISCHARGES (CFS x 10^3)

Red River Landing

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1950			1162	1134	947	778	654	547	477	423	352	375
1951	457	631	774	893	892	751	693	590	533	371	340	445
1952	618	774	794	851	815	701	474	296	218	165	134	159
1953	208	323	456	600	704	670	557	380	241	169	124	118
1954	155	230	283	313	378	385	358	240	186	171	186	194
1955	260	315	503	662	692	562	363	273	202	178	168	188
1956	162	321	520	680	611	446	327	260	215	173	135	153
1957	211	429	552	698	705	810	776	611	379	239	289	460
1958	593	616	537	533	647	659	633	563	488	404	253	239
1959	259	482	681	312	715	597	458	373	284	342	357	458
1960	497	569	574	613	612	584	490	372	284	197	187	196
1961	238	264	474	700	906	857	651	464	313	293	298	409
1962	521	663	780	921	872	686	426	285	226	213	217	219
1963	227	229	337	461	487	401	246	193	140	121	112	117
1964	130	156	256	405	606	568	460	241	178	140	141	183
1965	229	309	370	451	459	395	284	201	172	180	182	181
1966	209	359	505	482	451	342	311	185	135	128	131	165
1967	188	202	224	265	340	356	347	271	205	158	160	218
1968	309	377	370	411	410	463	347	274	151	130	125	189
1969	243	387	429	481	431	380	325	238	200	159	156	170
1970	212	245	306	345	426	413	332	211	153	167	194	215
1971	242	263	370	360	342	233	196	168	148	141	133	190
1972	273	320	342	319	369	299	262	177	171	166	236	351
1973	466	521	533	626	714	731	550	335	190	181	209	360
1974	522	692	688	614	473	428	328	263	184	158	189	213
1975	299	302	384	440	562	531	441	302	224	206	222	245
1976	285	307	343	326	319	274	254	215	183	162	164	175
1977	171	167	257	362	395	298	198	166	174	194	241	335
1978	358	365	324	406	487	477	375	251	198	154	127	227
1979	361	496	592	725	858	831	637	431	312	285	268	303

The time variable included in each equation was used to determine the salinity-probability distributions predicted for the years 1980 and 2030. Probability curves showing combined spring and summer 1980 and 2030 conditions are described on plates C-5 through C-7. Salinities at the "Ford line" were also determined (see plate C-8).*

C.1.39. Mississippi River Flow. The Mississippi River is the major available source of freshwater that could be diverted into the estuaries to improve productivity. Therefore, it is necessary to know the amount of flow likely to be available in the Mississippi River at any time during the year. The Red River Landing discharge station located just below the Old River Control Structure provides the best record of Mississippi River flow for use in this study. There are no major tributaries or distributaries between the Red River Landing station and the mouth of the Mississippi River. Table C-1-20 contains 3-month average discharge data for the period 1950-1979. A graphical plot of the data indicates that typical lowest flows occur in August through November. Gradual variations occur during the intervening months.

C.1.40. Stage Data. Water levels in the area were investigated at the Bayou Rigaud gage, Grand Isle, Louisiana, in the lower portion of Barataria Basin, and at the Bayou Des Allemands gage, Des Allemands, Louisiana, in the upper Barataria Basin. The period of record reviewed is from 1964 to 1979. Tables C-1-21 and C-1-22 present 3-month moving average stages for each site.

C.1.41. The Grand Isle gage is characterized by persistent high stages from May through October with an annual high usually occurring in September. The lowest stages in a given year are normally December through February. The Grand Isle stages are generally indicative of predominant seasonal wind patterns such as northerly air movements during the winter and southerly flows

*The "Ford Line" is the position of the 15 ppt mean isohaline across the coastal zone which represents desirable salinity conditions for maximizing productivity of commercial and sport fishery resources. The Ford line is widely supported by fish and wildlife experts (Louisiana Department of Wildlife and Fisheries, letter dated January 28, 1983, in Main Report.)

lag time for each variable. Then, sets of four best-fit binomial equations relating the dependent variable (salinity) to each of the independent variables were computed. A packaged Hewlett-Packard 97 calculator program, "Curve Fitting," was used to transform the lagged independent variable values into exponential, logarithmic, and power functions, in addition to the linear form. Trials were also made for longer and shorter lag times to obtain the best individual correlations. Multiple regression computations followed using optimal lag times for each variable.

C.1.36. This process, which included many graphical plots of paired variables and their best-fit lines or curves, revealed the need for a more satisfactory representation of seasonal effects. As the parameters interact, it is assumed that an attenuated response pattern develops because of the large available storage volumes, particularly in the lower basin, and the limited number of hydraulically efficient conveyance routes. This pattern would be better represented by using a longer time period, such as a 3-month moving average (as opposed to monthly mean). When the 3-month average values were used, correlations among the parameters improved and appeared to reflect known and perceived seasonal patterns of variation. Thus, the moving-average concept, with 3 months taken as the period length, was adopted for use thereafter in the analysis.

C.1.37. Another departure from the Center for Wetland Resources study was the time period investigated. Observed data through the year 1979 was employed and represented an extension of 11 years. However, the years prior to completion of the Barataria Bay Waterway project in 1963 were eliminated in recognition of the significant influence of the project on salinity levels and patterns in the upper estuary.

C.1.38. From the multiple regression computations, two equations were derived for each station with salinity as the dependent variable, one representing spring and the other representing summer. Only those independent variables that improved the correlation with salinity were included in each equation.

TABLE C-1-19

VARIABLES INCLUDED IN STATISTICAL ANALYSIS 1/

Variable Symbol	Variable Identification	Period of Record
MS7	Basin Moisture Surplus, Subbasins I&VII	1950-1979 inclusive
MS6	Subbasin Moisture Surplus, Subbasins I&VI	1950-1979 inclusive
MS5	Subbasin Moisture Surplus, Subbasins I&V	1950-1979 inclusive
RRL	Mississippi River at Red River Landing Discharge	1950-1979 inclusive
GI	Bayou Rigaud at Grand Isle Stage (NGVD)	1950-1979 2/
DA	Bayou des Allemands at des Allemands Stage (NGVD)	1950-1979 2/
LAF	Barataria Bay Waterway at Lafitte Salinity	Oct 1955-1979 inclusive
SMP	Barataria Bay at St. Mary's Point Salinity	Oct 1955-1978 3/
GTS	Barataria Bay at Grand Terre Slip Salinity	Feb 1959-1978 4/
GIP	Gulf of Mexico at Grand Isle Offshore Platform Salinity	Mar 1960-1969 5/
TY	Time in Years since 1964	—

1/ Detailed analysis period was 1964-1979.

2/ Some months missing - estimates made by comparison with related records.

3/ Some months missing - estimates made by statistical correlation with Lafitte and Grand Terre Slip station records.

4/ 1979 data missing - estimated by comparison with Lafitte station record.

5/ 1970-1978 estimated by statistical correlation with Grand Terre Slip station records. 1979 estimated by comparison with Lafitte station record.

resulting correlation indices were examined and predicted salinities were compared to observed salinities to determine the optimal equation for each salinity-monitoring station.

C.1.32. The Center for Wetlands analysis provided a basis for the statistical analysis performed in this study. The differences between the two studies include the time period investigated, derivation of moisture surplus, variable transformations, and incorporation of seasonal differences into optimal equations. A degree of departure was dictated at the outset because no computer program was available with the capability of ordering and selecting combinations of progressively-lagged variables into the regression computations.

C.1.33. Procedural Basis. The Barataria Bay salinity variations are functionally related to Mississippi River flows as well as basin rainfall and wind-generated water movement. The analysis performed as part of this study defines statistical seasonal relationships between salinity at four gage locations and externally and internally generated freshwater flow, basin moisture surplus, and two water levels (at gages at each end of the estuarine area). Time was included in the analysis to represent the continuing effects of land subsidence, erosion, and rise in sea level on salinity. Table C-1-19 identifies the parameters included in the analysis.

C.1.34. Wind data are excluded from the list of variables. The rationale for this exclusion is that typical short duration (one to four days) patterns of wind movement would affect monthly mean water and salinity levels only slightly. However, longer periods of sustained wind movement and direction would be reflected in water and salinity levels. Therefore, the effects of wind are considered to be incorporated into the analysis already.

C.1.35. Graphical plots of monthly mean parameter values were first visually compared with the monthly mean salinity plots to obtain the apparent optimal

to maintain brackish conditions (less than 15 ppt) in the Barataria Bay estuary. However, during the dry year, 1963, runoff was short one-third that of the wet year. As a result, saline water in excess of 15 ppt was present in Barataria Bay throughout the year. The 15 ppt isohaline remained at or near the mouth of the bay from March through September 1961. In 1963, the 15 ppt isohaline moved about 12 miles north and stayed near the middle of the bay from January through November. Yields during the spring-summer period varied from a surplus of 11,700 cfs in 1961 to a deficit of -6,300 cfs in 1963. Similar conditions probably existed in the other Louisiana estuaries including Breton Sound.

FUTURE SALINITY CHANGE (BARATARIA BAY)

C.1.30. To determine future salinity levels, a statistical analysis correlating salinity to other influencing parameters, and vice versa, was made using available data. By comparing future salinity levels to existing conditions the magnitude of salinity changes are determined. This information is needed in developing a management scheme for diverting freshwater to the Barataria Basin consistent with improving productivity. The influence of salinity on productivity, specifically the 15 ppt isohaline, is given in Appendix A, Problem Identification.

C.1.31. A similar statistical analysis was conducted by the Center for Wetland Resources of Louisiana State University. In that study, a statistical correlation of station mean salinities was made with weighted moisture surplus amounts in Barataria Basin, water levels at the Bayou Rigaud gage on Grand Isle, and Mississippi River flow volumes (Gagliano et al., 1970 b). A linear equation was developed for each of four salinity monitoring stations in Barataria Basin. Lagged monthly or monthly mean values of independent variables (moisture surplus, water levels, and flow) along with values of the dependent variable (salinity) were input to a computer program that was used to generate regression coefficients for combinations of variables. The

TABLE C-1-18

RELATIONSHIP OF WATER YIELD TO SALINITY

Barataria Bay, 1961 And 1963 *

Estuary	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1961												
Salinity p.p.t.	7.8	9.8	5.0	5.2	7.5	4.3	2.1	3.2	7.9	10.0	13.3	6.5
Water yield Thousands c.f.s.	12.9	20.8	18.8	2.1	0.6	6.5	3.8	3.3	4.7	-1.2	12.4	14.8
1963												
Salinity p.p.t.	15.1	11.0	16.9	22.6	22.6	18.2	13.8	20.3	19.6	21.1	15.9	7.3
Water yield Thousands c.f.s.	8.5	11.4	-2.7	-6.1	-6.4	2.9	0.1	-5.8	3.2	-7.1	19.0	11.4

* Water yield from Gagliano et al., 1970f. Salinities for Barataria Bay at Manila Village from Gagliano et al., 1972.

highs reflect the general tendency of saline gulf waters to move northward and encroach into the estuarine water bodies during the warm weather months. This northward movement is reinforced by the seasonally-reduced freshwater flows from within and outside the Barataria Basin.

C.1.28. In a study conducted by the Center for Wetland Resources, a general relationship between salinity and runoff in the estuaries was established using a representative wet year, 1961, and a dry year, 1963 (Gagliano et al., 1970 a, b, c, d, f, and 1972). These two extreme periods provide a minimum and maximum range under which a comparison between salinity and runoff can be made. The seasonal values at key control stations for 1961 and 1963 are presented in table C-1-17.

TABLE C-1-17

SEASONAL SALINITY VALUES

Bayou La Loutre at Hopedale (Breton Sound)
Barataria Bay at Manila Village (Barataria Basin)

Area	Winter		Spring		Summer		Autumn	
	1961	1963	1961	1963	1961	1963	1961	1963
				(PPT)				
Breton Sound	6.4	13.0	6.1	15.6	6.7	17.8	5.7	17.9
Barataria Basin	11.4	14.6	5.9	21.0	3.7	17.4	10.6	18.9

SOURCE: Gagliano et al. (1970 f)

C.1.29. The runoff associated with these salinity values was determined using the Thornwaite-Mather Water Balance Model. Water yields of the Barataria Bay watershed were compared to salinities values for the year 1963 and 1961 and are shown in table C-1-18. Runoff during the wet year, 1961, was sufficient

TABLE C-1-16

MONTHLY MEAN SALINITIES FOR BARATARIA BAY

Lafitte

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave Ann
1956	1.8	1.3	0.9	1.3	1.7	2.4	1.1	1.3	2.4	1.1	1.5	1.5	
1957	1.1	1.3	0.8	0.6	0.9	0.9	0.8	0.9	1.3	1.1	1.7	0.9	
1958	0.8	0.6	0.4	0.4	0.9	0.9	0.9	0.6	0.9	0.8	1.1	1.1	
1959	1.5	0.8	0.6	0.6	2.4	0.8	0.4	0.4	2.6	2.0	1.3	1.3	
1960	1.1	0.9	0.6	0.6	0.9	2.2	1.8	2.4	2.2	2.0	1.8	2.4	
1961	1.5	0.9	0.6	0.4	0.8	0.6	0.6	0.6	2.9	2.0	2.9	1.3	
1962	0.6	0.8	0.9	1.7	3.8	4.5	3.1	4.9	5.6	5.8	4.7	4.2	
1963	3.3	2.4	2.2	4.9	4.7	4.7	2.2	2.2	4.5	4.9	3.5	2.2	
1964	1.3	0.9	0.8	0.8	0.8	1.1	0.9	0.8	2.7	5.1	3.3	2.6	
1965	1.7	1.1	3.8	1.7	5.8	6.0	4.0	3.1	5.3	3.8	4.5	3.5	
1966	1.3	1.1	0.9	1.5	1.5	0.8	0.6	0.8	0.9	1.5	2.4	2.7	
1967	1.5	0.9	1.5	6.0	6.7	8.7	5.6	4.9	3.8	4.2	3.3	3.1	
1968	1.8	1.5	1.7	2.7	2.6	1.7	1.8	2.0	4.0	5.1	3.6	2.7	
1969	1.8	1.7	1.1	0.9	0.9	1.1	1.3	1.5	2.4	7.4	5.6	4.7	
1970	2.4	2.6	1.8	4.0	5.6	2.9	2.7	2.4	1.8	2.2	1.8	2.2	
1971	1.8	1.1	1.1	2.2	5.8	3.5	2.2	2.2	0.9	1.1	2.0	1.3	
1972	0.8	0.6	0.6	3.8	4.9	4.5	5.8	4.7	10.3	9.8	7.1	3.1	
1973	2.0	1.1	1.1	0.8	0.9	0.8	0.8	1.3	4.9	2.6	2.2	2.0	
1974	0.8	0.6	0.6	0.6	0.8	0.8	0.8	1.1	4.0	3.8	4.2	1.5	
1975	1.1	1.1	0.9	0.9	0.5	0.6	0.4	0.4	0.4	0.6	1.1	1.3	
1976	0.9	0.6	1.3	2.9	2.2	3.1	2.2	3.6	6.2	5.4	5.1	2.0	
1977	1.3	1.3	2.2	6.2	5.1	5.4	6.3	4.4	4.9	2.6	2.0	0.9	
1978	0.6	0.4	0.6	1.1	0.9	0.6	0.8	0.9	1.7	2.6	2.7	1.8	
1979	0.8	0.4	0.4	1.7	0.9	0.4	1.8	1.1	2.2	2.6	3.5	2.5	
MEAN													
'56-'79	1.4	1.1	1.1	2.0	2.6	2.5	2.0	2.0	3.3	3.4	3.1	2.2	2.2
MEAN													
'56-'63	1.5	1.1	0.9	1.3	2.0	2.1	1.4	1.7	2.8	2.5	2.3	1.9	1.8
MEAN													
'64-'79	1.4	1.1	1.3	2.4	2.9	2.6	2.4	2.2	3.5	3.8	3.4	2.4	2.5

TABLE C-1-15

MONTHLY MEAN SALINITIES FOR BARATARIA BAY

St. Mary's Pt.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave Ann
1955										12.2	10.8	14.9	
1956	14.2	7.7	12.2	11.2	10.1	22.0	9.9	7.6	22.0	9.9	8.8	16.2	
1957	9.9	7.4	11.9	6.7	4.9	12.4	7.9	4.9	14.9	9.9	10.1	12.2	
1958	7.9	3.2	8.8	5.6	5.0	11.9	9.0	3.1	11.9	8.5	6.1	13.1	
1959	13.0	7.7	6.5	7.2	18.0	7.7	5.9	5.0	19.3	16.4	10.8	10.8	
1960	10.8	8.1	10.4	7.0	9.5	18.3	19.1	15.2	14.8	15.3	13.8	16.6	
1961	7.8	9.8	5.1	5.2	7.5	4.3	2.1	3.3	7.9	10.0	13.4	6.5	
1962	5.2	8.9	11.5	10.8	13.0	13.1	14.4	21.7	21.2	22.4	20.6	18.5	
1963	17.1	11.1	18.4	21.8	19.8	17.3	10.7	11.6	19.5	20.8	15.1	6.9	
1964	8.6	7.2	4.5	5.7	7.9	10.7	6.6	6.8	21.9	15.8	19.8	15.4	
1965	12.5	9.8	11.2	13.2	14.8	15.7	14.6	13.6	11.9	25.6	18.0	14.2	
1966	18.5	6.5	7.9	11.1	9.0	18.3	12.1	6.8	12.4	20.9	19.0	14.2	
1967	12.6	6.2	11.8	8.7	4.7	16.8	20.9	17.7	17.0	13.4	17.0	15.7	
1968	7.2	12.6	15.2	16.3	13.4	13.7	14.7	14.4	18.0	19.2	20.0	14.6	
1969	15.4	12.5	5.3	10.6	7.4	10.6	12.4	13.7	14.5	22.7	21.8	19.0	
MEAN '55-'69	11.5	8.5	10.1	10.1	10.4	13.8	11.5	10.4	16.2	16.2	15.0	13.8	12.3
MEAN '55-'63	10.7	8.0	10.6	9.4	11.0	13.4	9.9	9.1	16.4	13.9	12.2	12.1	11.4
MEAN '64-'69	12.5	9.9	9.4	12.8	12.4	14.3	13.6	12.2	16.0	19.6	19.3	15.5	14.0

TABLE C-1-24

MONTHLY MEAN MOISTURE SURPLUS (CFS)
Subbasins I-VI

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1964	8329	5286	4385	3273	54	0	3310	123	0	2055	1416	1783
1965	4448	4048	935	0	34	0	57	1353	2763	0	1	5354
1966	11554	9451	427	2674	4377	0	2945	907	1172	434	0	3034
1967	3342	5590	196	0	90	0	467	2681	1362	1465	0	6695
1968	543	2722	1357	358	532	433	6	77	0	10	2052	5659
1969	1724	3033	5644	3127	1115	0	565	3	0	0	5	3141
1970	2733	1072	4689	0	857	67	11	2011	840	2073	135	1537
1971	750	3278	2122	0	0	297	3283	90	7246	282	484	4238
1972	5211	4759	3267	0	741	109	1124	0	203	535	5322	6233
1973	2479	3020	7125	7833	336	0	146	171	5231	228	1057	7147
1974	4577	1658	3505	869	1201	0	751	1876	796	0	3614	3563
1975	2081	2433	3329	1421	2560	139	1746	3318	389	258	1319	2463
1976	1422	2970	1863	0	990	897	83	0	0	1682	4042	7845
1977	4657	1611	2346	1652	0	0	0	5652	3034	1645	8868	3056
1978	10536	2333	1919	695	3275	1433	822	1359	617	0	2222	2764
1979	4679	10386	1362	3533	1161	0	1851	0	493	0	1490	1828

TABLE C-1-25

MONTHLY MEAN MOISTURE SURPLUS (CFS)

Subbasins I-VII

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1964	13827	11123	7691	4478	53	212	5713	1026	259	4406	1800	1878
1965	8040	10655	4932	0	34	1749	1293	4491	5981	0	1	10882
1966	[illegible]	13536	912	5259	10320	0	4351	3655	3992	1057	601	9117
1967	6775	7864	413	0	264	0	719	6763	4342	9548	0	13794
1968	[illegible]	5750	2674	1275	2371	433	6	77	0	10	4128	11355
1969	[illegible]	5857	11498	4858	5569	0	2749	2472	0	0	150	6915
1970	5833	2117	12206	0	2167	67	631	7117	2649	6992	147	2550
1971	3713	9633	6467	0	0	926	5555	5415	13602	282	1090	7779
1972	10947	10107	6361	2	8589	109	2294	0	203	1261	11401	10556
1973	5314	5326	16007	19543	336	0	408	171	7714	1847	1494	12875
1974	10040	1650	5884	7924	[illegible]	0	751	3759	2845	0	7196	5448
1975	3906	3315	4733	3262	11393	5807	2425	5835	4670	1221	5327	5167
1976	2773	5151	5506	0	5697	897	83	0	479	3735	10312	15185
1977	10113	3074	4935	1652	0	0	1268	9898	7537	2969	15728	7640
1978	21651	4793	6549	1933	3275	1433	1796	3602	2126	0	5862	6464
1979	9571	[illegible]	4579	6862	6112	0	7624	0	1939	0	4812	4649

subbasin unit in order to approximate the actual timing of runoff fo Barataria Basin as a whole. Three-month average moisture surpluses were computed and are presented for combined subbasins I-VI in table C-1-26 and for subbasins I-VII in table C-1-27.

C.1.47. Salinity Station Probability Distribution. Given the influence of salinity on productivity, it was necessary to determine the probability of a given salinity level occurring during a year at the four selected monitoring stations. The monthly mean salinity data were converted to 3-month averages because of the attenuated response patterns of parameters in the estuary (see tables C-1-28 through C-1-31). Spring (April-June) and summer (July-September) sets of averaged salinity data for 1964-1979 were each fitted to a Pearson Type III probability distribution. Statistical parameters including Mean, Adjusted Standard Deviation, and Adjusted Skewness were computed with another WESLIB program "STAT 1." Salinity coordinates corresponding to 1, 10, 30, 50, 70, 90, and 99 precent exceedance probabilities were determined by the equation $X=M+KS$, where M represents the mean, K is a factor that is a function of the skew coefficient and the selected exceedance probability, and S is the standard deviation. The K values for each probability distribution were selected from "Guidelines for Determining Flood Flow Frequency," Bulletin No. 17A of the Hydrology Committee, US Water Resource Council (1977).

C.1.48. Optimal Lag Time. A final preliminary operation to the multiple regression analysis of 3-month data sets was determining optimal lag time and mathematical transforms for all independent variables with respect to salinity. A curve-fitting program (Hewlett-Packard 97 calculator program) was used to systematically accomplish this task. Beginning with the apparent best lag time according to visual comparisons of the monthly mean salinity and independent variables (moisture surplus, discharge, and stages), four curve types (linear, exponential, logarithmic, and power function) were fitted to each pair of data sets. Best fit-equations for the four curve types were

TABLE C-1-26

THREE-MONTH AVERAGES MOISTURE SURPLUS (CFS)

Subbasins I-VI

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1950			1881	3453	2760	1939	353	353	175	0	2	1577
1951	2713	3060	3162	3028	2742	1065	64	1	91	90	488	1169
1952	1354	3419	3169	4151	2343	1824	943	288	292	4	94	1942
1953	2225	3802	2667	3293	1625	1121	1454	1902	1690	449	1762	4625
1954	5737	4060	1270	1158	461	389	973	585	1010	619	866	1533
1955	3031	3397	2805	1513	401	400	777	1478	1776	999	958	1353
1956	1765	3174	3084	2517	1005	1056	1010	872	1187	932	1182	1672
1957	1696	1886	2580	3620	3289	1581	504	559	1619	1816	2766	1998
1958	3744	3753	4938	3168	2559	719	919	684	1375	1002	768	20
1959	681	3546	4208	3675	3726	3559	5320	2500	1965	1062	1081	1615
1960	1747	3255	3413	3078	1502	809	26	68	68	241	173	855
1961	2518	5100	6831	5235	2923	1171	1269	537	1806	1504	2707	3816
1962	4999	3332	1398	236	173	199	133	141	8	8	43	690
1963	1867	3140	2493	1316	0	207	70	70	271	108	428	3803
1964	6579	6022	6000	4314	2570	1109	1121	1144	1144	726	1157	1751
1965	2549	3426	3143	1661	323	11	30	470	1391	1372	921	1785
1966	5633	8783	7141	4184	2492	2350	2440	1284	1674	837	535	1156
1967	2125	3935	3039	1925	195	30	186	1049	1503	1833	939	2716
1968	2412	3320	1541	1479	749	441	324	172	28	29	687	2574
1969	3145	3473	3469	3936	3296	1414	560	190	190	1	2	1049
1970	1960	2315	2831	1920	1849	308	312	696	954	1641	1016	1248
1971	837	1855	2050	1800	707	99	1193	1223	3540	2539	2671	1868
1972	3511	4936	4412	2675	1336	283	658	411	442	263	2037	4046
1973	4678	3910	4203	5992	5098	2723	1161	106	1849	1876	2172	2811
1974	4260	4461	3247	2011	1858	690	651	876	1141	891	1470	2392
1975	3086	2632	2614	2394	2437	2707	2815	3068	1818	1322	655	1347
1976	1735	2285	2085	1611	951	629	657	327	28	561	1908	4523
1977	5515	4704	2371	1870	1333	551	1	1884	2835	[illegible]	4513	[illegible]
1978	7447	5308	4929	1649	1963	1801	1843	1205	933	659	946	[illegible]
1979	3222	5943	5475	5093	2018	1564	1004	617	781	164	661	1106

TABLE C-1-[illegible]

THREE-MONTH AVERAGES MOISTURE SURPLUS (CFS)

Subbasins I-VII

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1950			3947	6660	5489	3439	2190	2190	1653	824	826	3947
1951	4635	5382	4417	5486	4799	2643	1099	1036	2102	1065	2476	2764
1952	3198	6678	5894	7696	3460	2390	941	925	1218	931	404	2492
1953	3024	6584	5051	6425	2753	2470	1856	2816	2251	960	3700	10909
1954	12952	9342	206	163	461	395	2538	2150	4129	2365	2826	3425
1955	5546	6691	4105	2248	642	642	2239	4699	5833	3664	2490	2689
1956	4441	6170	5519	4360	1483	2846	2708	2965	5266	4803	4608	2875
1957	2899	3089	2894	4241	3910	2330	946	1109	2293	2490	3666	2373
1958	5193	5795	7299	4454	3032	826	1090	1209	1959	1523	827	105
1959	4039	8847	9689	6230	4318	5054	7686	5622	3939	3583	3103	3919
1960	3332	5985	6525	5720	2735	1385	26	1397	1397	2803	1405	3301
1961	5412	9214	11363	8406	5301	3936	3949	5206	3867	3339	4285	6297
1962	8757	5965	2790	352	246	214	148	156	248	363	905	1774
1963	3885	6238	5130	2904	0	1224	1889	1889	785	620	4675	7560
1964	12169	11822	10880	7764	4074	1581	1095	2319	2335	1897	2155	2695
1965	3906	6857	7876	5196	1656	594	1025	2511	3922	3491	1994	3628
1966	10828	11340	8016	7569	5497	5193	4890	2668	4000	2902	1884	3592
1967	5498	7919	5018	2759	226	88	327	2494	3941	6884	4630	7781
1968	5559	7476	3769	3233	2107	1360	937	172	153	29	1379	5164
1969	6623	7199	7247	7404	7308	3475	2772	1740	1740	824	50	2355
1970	4299	4955	6719	4774	4791	745	955	2605	3466	5586	3263	3230
1971	2137	5299	6604	5367	2156	309	161	3966	1891	6433	4991	3050
1972	6572	9578	9105	5490	4984	2900	3664	801	832	488	4288	7739
1973	9290	7465	9282	13825	11962	6626	248	193	2764	3244	3685	3405
1974	8136	8191	5861	5155	6165	4204	1813	1503	2452	2201	3347	4215
1975	5543	4450	4211	3970	6463	6821	6542	4689	4310	3909	3739	3905
1976	4422	4364	4504	3579	3761	2198	2225	326	187	1405	4842	9744
1977	11872	9459	6059	3237	2212	551	423	3722	6234	6801	8745	8779
1978	15006	11361	10997	4425	3919	2414	2168	2277	2508	1909	2663	4109
1979	7299	12205	11610	10707	5884	4225	4579	2541	3204	663	2267	3153

TABLE C-1-28

THREE-MONTH AVERAGE SALINITY

Lafitte

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1955												1.5
1956	1.6	1.5	1.3	1.2	1.3	1.8	1.7	1.6	1.6	1.6	1.7	1.4
1957	1.4	1.3	1.1	0.9	0.8	0.8	0.9	0.9	1.0	1.1	1.4	1.2
1958	1.1	0.8	0.6	0.5	0.6	0.7	0.9	0.8	0.8	0.8	0.9	1.0
1959	1.2	1.1	1.0	0.7	1.2	1.3	1.2	0.5	1.1	1.7	2.0	1.5
1960	1.2	1.1	0.9	0.7	0.7	1.2	1.6	2.1	2.1	2.2	2.0	2.1
1961	1.9	1.6	1.0	0.6	0.6	0.6	0.7	0.6	1.4	2.0	2.8	2.3
1962	1.6	0.9	0.8	1.1	2.1	3.3	3.8	4.2	4.5	5.4	5.4	4.9
1963	4.1	3.3	2.6	3.2	3.9	4.8	3.9	3.0	3.0	3.9	4.3	3.5
1964	2.3	1.5	1.0	0.8	0.8	0.9	0.9	0.9	1.5	2.9	3.7	3.7
1965	2.5	1.8	2.2	2.2	3.8	4.5	5.3	7.7	4.1	4.1	4.5	3.9
1966	3.1	2.0	1.0	1.1	1.2	1.3	1.0	0.7	0.8	1.1	1.6	2.2
1967	2.2	1.7	1.3	2.8	4.7	7.1	7.0	6.4	4.8	4.3	3.9	3.7
1968	2.9	2.1	1.7	2.0	2.3	2.3	2.0	1.8	2.6	3.7	4.2	3.8
1969	2.7	2.1	1.5	1.2	1.0	1.0	1.1	1.3	1.7	3.8	5.1	5.9
1970	4.2	3.2	2.3	2.8	3.8	4.2	3.7	2.7	2.3	2.1	1.9	2.1
1971	1.9	1.7	1.3	1.5	3.0	3.8	3.8	2.6	1.8	1.4	1.3	1.1
1972	1.4	0.9	0.7	1.7	3.1	4.4	5.1	5.0	6.9	8.3	9.1	6.7
1973	4.1	2.1	1.4	1.0	0.9	0.8	0.8	1.0	2.3	2.9	3.2	2.3
1974	1.7	1.1	0.7	0.6	0.7	0.7	0.8	0.9	2.0	3.0	4.0	3.2
1975	2.3	1.2	1.0	1.0	0.9	0.8	0.6	0.5	0.4	0.5	0.7	1.0
1976	1.1	0.9	0.9	1.6	2.1	2.7	2.5	3.0	4.0	5.1	5.6	4.2
1977	2.8	1.5	1.6	3.2	4.5	5.6	5.6	5.4	5.2	4.0	3.2	1.8
1978	1.2	0.6	0.5	0.7	0.9	0.9	0.8	0.8	1.1	1.7	2.3	2.4
1979	1.8	1.0	0.5	0.8	1.0	1.0	1.0	1.8	1.7	2.0	2.8	2.5

TABLE C-1-29

THREE-MONTH AVERAGE SALINITY

St. Mary's Point

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1955												12.6
1956	13.3	12.2	11.3	10.4	11.2	14.4	14.0	13.1	13.1	13.1	13.5	11.7
1957	11.7	11.2	9.7	8.6	7.7	7.9	8.5	8.5	9.2	9.9	11.7	10.8
1958	10.1	7.7	6.7	5.9	6.5	7.6	8.6	7.9	7.9	7.7	8.8	9.2
1959	10.8	11.3	9.0	7.2	7.6	11.0	10.6	6.3	10.1	13.5	15.5	12.6
1960	10.8	9.9	9.7	8.5	9.0	11.7	15.7	17.5	16.4	15.1	14.6	15.3
1961	12.8	11.3	7.6	6.7	5.9	5.8	4.7	3.2	4.5	7.0	10.4	9.9
1962	8.3	6.8	8.5	10.4	11.7	12.2	13.5	16.4	19.1	21.8	21.4	20.5
1963	18.7	15.7	15.5	17.1	20.0	19.6	15.8	13.1	13.9	17.3	18.5	14.2
1964	10.3	7.6	6.8	5.8	6.1	8.1	8.5	8.1	11.9	14.9	19.3	17.1
1965	15.8	12.6	11.2	11.3	13.0	14.6	14.9	14.6	13.3	17.1	18.5	19.2
1966	16.9	14.8	12.6	7.7	8.5	12.0	13.1	12.4	10.4	13.3	17.5	18.0
1967	15.3	11.0	10.3	12.4	16.7	18.4	18.9	18.4	18.5	16.0	15.7	15.3
1968	13.3	11.9	11.7	14.8	14.9	14.4	13.9	14.2	15.7	17.3	19.1	18.0
1969	16.7	14.2	11.0	9.4	7.7	9.5	10.1	12.2	13.5	16.9	19.6	21.2
1970												
1971												
1972												
1973				7.3	5.0	5.4	6.1	8.8	14.0			
1974				6.7	7.0	6.9	8.8	12.1	14.6	17.4	18.3	18.6
1975				11.4	9.7	7.0	6.3	5.6	8.1	9.5	11.9	14.3
1976	12.8	11.8	10.7	12.3	12.9	14.4	14.7	17.3	18.7	21.4	21.7	19.8
1977	17.5	17.5	18.2	18.9	18.5	19.1	19.7	20.0	17.0	15.0	13.4	
1978				7.3	7.6	8.7	9.5	10.0	11.8			19.9

TABLE C-1-30

THREE-MONTH AVERAGE SALINITIES

Barataria Bay at Grand Terre Slip

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1959				21.9								
1960												
1961						17.5	14.3	14.5	16.9	19.3	22.2	
1962			21.0	20.2	18.5	17.2	18.8	22.4	24.6	26.6	27.6	29.3
1963	29.4	29.3	28.6	26.0	24.8	23.9	25.0	23.8	25.2	26.9	26.6	25.6
1964	23.9	23.6	24.4	21.3	18.0	15.7	16.9	20.4	24.0	26.2	26.9	26.3
1965	25.6	24.6	23.2	20.8	17.6	15.2	18.0	21.1	24.3	24.1	25.1	25.3
1966	24.5	22.4	19.8	20.3	19.1	19.4	19.3	19.1	20.5	21.1	25.1	25.0
1967	22.6	19.1	18.7	18.9	20.8	20.4	22.0	22.5	23.5	24.4	24.8	25.6
1968	24.4	23.8	24.3	22.5	20.1	17.5	18.5	19.1	21.1	23.9	27.3	28.3
1969	28.0	26.6	25.0	22.8	19.2	17.8	18.3	20.2	21.9	23.9	27.4	29.4
1970	27.9	26.5	24.9	23.8	19.9	17.9	17.8	20.2	21.0	21.6	22.2	22.9
1971	23.1	23.4	23.1	22.0	21.4	21.8	23.8	23.4	21.0	17.8	18.6	22.0
1972	23.4	22.7	20.9	21.4	20.9	21.1	22.3	24.0	25.8	27.1	27.1	25.5
1973	21.2	19.2	17.6	16.2	14.7	13.6	16.8	16.3	22.2	21.2	26.2	27.5
1974	24.0	18.9	15.0	15.9	16.6	16.4	17.0	19.8	21.7	25.4	27.3	28.8
1975	26.0	21.5	19.4	17.3	14.6	11.9	12.5	15.6	18.0	19.3	21.3	24.2
1976	26.0	26.0	24.6	21.6	21.8	21.4	23.2	23.4	24.3	26.0	26.5	26.5
1977	25.9	26.2	25.5	22.7	19.2	19.5	20.7	22.6	21.1	20.9	21.2	22.4
1978	21.8	21.7	21.5	19.4	17.1	14.5	16.9	18.0	18.8	19.1	21.1	23.5

TABLE C-1-31

THREE-MONTH AVERAGE SALINITIES

Gulf of Mexico at Grand Isle Platform

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1960					24.7	23.7	24.5	25.1	25.3	25.5	26.7	28.5
1961	29.8	30.1	28.0	25.8	22.3	19.1	17.9	19.2	22.9	24.6	26.2	26.6
1962	26.7	24.7	24.3	22.4	21.4	19.8	21.8	24.3	26.4	26.7	27.9	29.0
1963	29.8	30.2	29.2	26.2	24.9	24.9	27.5	28.6	29.2	29.3	29.6	30.8
1964	31.5	31.6	30.0	25.3	20.2	16.8	19.4	22.9	26.7	28.1	28.8	29.2
1965	28.2	28.0	27.0	23.7	21.8	19.2	22.2	24.7	26.6	26.8	27.1	27.8
1966	28.1	27.5	25.0	24.7	23.7	24.1	23.0	25.3	26.8	27.7	28.3	28.9
1967	28.6	28.3	27.5	24.7	23.7	22.0	24.5	24.9	26.2	26.8	27.5	28.3
1968	27.5	26.8	26.6	23.7	21.7	18.8	20.4	21.2	23.4	25.2	27.4	28.8
1969	28.7	27.3	26.1	24.7	22.3	20.6	21.8	24.1	25.8	26.0	27.2	28.7

computed for each data set. Lag times one month shorter and longer were assumed and the process was repeated. Unless r^2, the determination coefficient, was significantly higher for the middle lag time than for the other two, trials would be continued in either or both directions until an overall best-fit curve equation was determined for each curve type. This process resulted in the selection of the optimal combination of lag time and transform for each pair of variables.

C.1.49. Analyses of the correlations of paired variables produced the best correlation of salinity with:

- o Exponential functions of moisture surplus
- o Log functions of Red River Landing flow
- o Linear functions of Grand Isle stage
- o Exponential functions of Des Allemands stage

The best fit curve values for each of the salinity reference stations for the four independent variables listed above are presented in tables C-1-32 to C-1-35.

C.1.50. Multiple Regression Analysis. Multiple correlation analyses were conducted using April-June (spring) and July-September (summer) salinity at each of the four monitoring stations as the dependent variable. Eight equations were derived. Optimal lag times and mathematical transformations previously derived were employed for the independent variables in each equation. Time in years was included as a fifth independent variable in order to account for any temporal trends that would reflect the other influencing factors not specifically represented. A computer program, "Step-Wise Multiple Linear Regression," was used for the correlation analyses. In the analysis, each transformed independent variable was introduced in turn and a best-fit relationship was determined (such that the standard error of the

TABLE C-1-32

SALINITY CORRELATIONS

St. Mary's Point
(Y=SMP)

Independent Variables	3 Month Avg.	April - June					3 Month Avg.	July - September				
		r^2	a	b	x_{50} [1]	x_{10}		r^2	a	b	x_{50}	x_{10}
Red River Landing Q $Y=a+b \ln x$	Mar-May	0.62	77.84	-10.69	63	95	Apr - Jun	0.18	42.58	-4.78	453	146
Moisture Surplus $Y=ae^{bx}$	Apr-Jun	0.62	15.43	-.00026	957	-218	May-Jul	0.51	16.25	-.0023	1616	-615
Grand Isle Stage $Y=a+b\,x$	Mar-May	0.06	15.66	-2.93	0.94	-0.74	May-Jul	0.09	18.65	-3.83	1.39	-0.02
Des Allemands Stage $Y=ae^{bx}$	Feb-Apr	0.11	17.14	-0.34	0.83	-0.12	Mar-May	0.02	15.02	-0.11	1.09	-2.02

1/ X values represent independent variable most likely to occur in associated with 50 percent or 10 percent exceedance at St. Mary's Point (April-June or July-September) salinity for 1964-1979 period.

TABLE C-1-33

SALINITY CORRELATIONS

Lafitte
(Y=LAF)

Independent Variables	3 Month Avg.	April - June					3 Month Avg.	July - September				
		r^2	a	b	x_{50} [1/]	x_{10}		r^2	a	b	x_{50}	x_{10}
Red River Landing Q $Y=a+b\ln x$	Feb-Apr	0.54	36.50	-5.60	43	64	Mar-May	0.26	23.18	-3.34	497	229
Moisture Surplus $Y=ae^{bx}$	Apr-Jun	0.61	3.95	-.00069	759	-434	May-Jul	0.73	4.14	-.00075	721	275
Grand Isle Stage $Y=a+bx$	Feb-Mar	0.20	4.13	-2.61	0.67	-0.44	Mar-May	0.11	4.33	- 1.74	1.09	-0.40
Des Allemands Stage $Y=ae^{bx}$	Jan-Mar	0.33	7.68	-1.73	0.68	0.22	Mar-May	0.02	3.50	-0.43	0.84	-0.84

1/ X values represent independent variable most likely to occur in associated with 50 percent or 10 percent exceedance at Lafitte (April - June or July-September) salinity for 1964-1979 period.

TABLE C-1-34

SALINITY CORRELATIONS

Grand Isle Offshore Platforms
(Y=GIP)

Independent Variables	3 Month Avg.	April - June					3 Month Avg.	July - September				
		r^2	a	b	x_{50} 1/	x_{10}		r^2	a	b	x_{50}	x_{10}
Red River Landing Q $Y=a+b \ln x$	Apr-Jun	.86	81.90	-10.35	406	265	Jun-Aug	0.25	45.40	-3.67	287	125
Moisture Surplus $Y=ae^{bx}$	Jan-Mar	.13	24.03	-.00031	6400	-180	Jun-Aug	0.19	26.65	-.00025	2033	-1515
Grand Isle Stage $Y=a+bx$	Jun-Aug	.31	29.28	- 7.58	1.26	0.68	Jul-Sep	0.40	30.56	- 3.89	1.35	0.74
Des Allemands Stage $Y=ae^{bx}$	Apr-Jun	.35	29.40	- 0.36	1.11	0.54	Jul-Sep	0.30	29.50	- 0.14	1.11	0.47

1/ X values represent independent variable most likely to occur in associated with 50 percent or 10 percent exceedance at Grand Isle Platforms (April - June or July - September) salinity for 1964-1979 period.

TABLE C-1-35

SALINITY CORRELATIONS

Grand Terre Slip
(Y=GTS)

Independent Variables	3 Month Avg.	April - June					3 Month Avg.	July-September				
		r^2	a	b	x_{50} [1]	x_{10}		r^2	a	b	x_{50}	x_{10}
Red River Landing Q Y=a+b lnx	Apr-Jun	0.83	71.36	-8.99	405	263	Jun-Aug	0.15	39.26	-3.20	240	101
Moisture Surplus $Y=ae^{bx}$	Feb-Apr	0 .24	20.74	-.00035	5004	-686	Jun-Aug	0.27	23.57	-.000039	2071	-983
Grand Isle Stage Y=a+bx	Jun-Aug	0 .30	25.60	-6.55	1.26	0.66	Jul-Sep	0.36	27.49	-4.24	1.36	0.71
Des Allemands Stage $Y=ae^{bx}$	Apr-Jun	0 .35	26.03	-0.37	1.10	0.55	Jul-Sep	0.29	26.52	-.18	1.12	0.45

1/ X values represent independent variable likely to occur in associated with 50 percent or 10 percent exceedance at Grand Terre Slip (April - June or July - September) salinity for 1964-1979 period.

TABLE C-1-39

ALTERNATIVE PLANS AND FLOWS (CFS)

[illegible]	[illegible]	Fortier	Barataria Basin Davis Pond	Oakville	Myrtle Grove	Breton Sound Big Mar
[illegible]	[illegible]	7,100		-	-	6,600
[illegible]	7,100	3,550		-	-	6,600
3	5,325	5,325		-	-	6,600
[illegible]	-	10,650		-	-	6,600
5	10,650	-		-	-	6,600
6	-	5,325		5,325	-	6,600
7	5,325	-		5,325	-	6,600
8	-	7,100		3,550	-	6,600
9	7,100	-		3,550	-	6,600
10	3,550	3,550		3,550	-	6,600
11	-	5,325		-	5,325	6,600
12	5,325	-		-	5,325	6,600
13	-	7,100		-	3,550	6,600
14	7,100	-		-	3,550	6,600
15	3,550	3,550		-	3,550	6,600
16			10,650			6,600

SITES FOR DETAILED ANALYSIS

Site	River Bank	River Mile
Bayou Lasseigne	West bank	141.0
Bayou Fortier	West bank	132.0
Davis Pond	West bank	118.4
Oakville	West Bank	70.4
Myrtle Grove	West bank	58.7
Big Mar	East bank	81.5

eliminating 16 sites on the west bank and two sites on the east bank. The remaining sites are listed in table C-1-38.

C.1.64. Diversion structures at Bayous Lasseigne and Fortier were designed to convey 100 percent, two-thirds, one-half, and one-third of the required flow. At the Davis Pond site, the structure was designed to convey 100 percent of the required flow. Structures at the Oakville and Myrtle Grove sites were each designed for one-half and one-third of the total flow. The decision to limit the lower sites to two flows was based on the short residual time that this diverted water would remain in the basin. The shorter the retention in the basin, the lesser the long-term affect on average salinity. The lower sites using the Barataria Bay Waterway as the conveyance channel were also limited to the existing channel capacity. Using the 6 remaining sites, 16 possible plans for the Barataria Basin were formulated. These plans are presented in table C-1-39.

C.1.65. From an hydraulic view, it was recognized that several distinct groups could be made from the 16 options in the Barataria Basin, which would aid in site evaluation. Options 1-5 and 16, diversion of 100 percent of the flow from the upriver sites, form Group 1. Group 2, composed of options 6, 7, 11, and 12, has a 50:50 ratio between flows at the upriver and downriver sites. Group 3, composed of the remaining options 8, 9, 10, 13, 14, and 15, has a 2:1 ratio between upriver and downriver sites, respectively. Salinity levels for with-project (groups 1 and 3 options) and without-project (1980 and 2030) conditions are shown on plate C-10 for the Lafitte station. No difference between Groups 2 and 3 is discernible on the frequency curves as they plot virtually on the same line. Similar curves are plotted for the St. Mary's Point and Grand Terre slip monitoring stations and the Ford line on plates C-11 through C-13. Based on a comparison of frequency plots, diversions under Group 1 provide lower salinity levels at the Lafitte and St. Mary's Point station. Similarly, Group 1 plans more closely achieve the Ford line at the 10-percent exceedance probabilities. With-project isohalines are

- The water volume in each zone was determined by using information from Chabreck (1972) and Barrett (1970).

- Ratios of fresh to fresh + saline water in each zone were assumed to be equal to a dilution factor and were multipled by the ambient (without-project) mean salinity at each short-term gage in the respective zone. It was also assumed that all diverted freshwaters would become completely mixed within the water bodies during the April through September period.

C.1.62. As a result of this procedure, reduced mean salinity levels at each of the short-term salinity gages were determined. With the new derived salinity values, the vegetation configuration, and the geometry of the area, new isohalines could be established. The procedure was repeated until the 15 ppt isohaline approximated the position of the Ford line. The initial volume of diverted freshwater analyzed was 2,200 cfs. Analyses conducted using this procedure determined the volume to be insufficient to maintain the Ford line salinity. In-sequence amounts of 4,400 cfs and 6,600 cfs were evaluated. The 6,600 cfs was determined as the probable required diverted flow needed to achieve the Ford line salinity.

HYDRAULICS

PROJECT SITE ANALYSIS

C.1.63. Based on the predicted need for an additional freshwater inflow of 10,650 cfs in the Barataria Basin and 6,600 cfs in the Breton Sound area, 21 possible diversion sites on the west bank and three diversion sites on the east bank of the Mississippi River were identified. The farthest upstream site was below Donaldsonville near river mile 175.5 and the farthest downstream site was Myrtle Grove (river mile 58.7). Preliminary evaluation of each site as discussed in Appendix B, Plan Formulation, resulted in

C.1.60. Given the limited data, future without-project salinity levels were estimated for the Breton Sound area by multiple regression correlations of monthly mean salinity levels (April through September) with respect to corresponding monthly mean stages and elapsed time for the period of record (1956-1977). The results of the analysis was the development of an average rate of change value for mean salinities at the Gardner Island station. The rate of change value was then multiplied by the difference in years between 2030 and the midpoint of the period of record to obtain the predicted 2030 average April through September salinity at the gage. Isohalines were then constructed using relationships developed between the Gardner Island gage and the short-term gages scattered throughout the area, vegetation configuration, geometry of the area, and saline zones identified by Chabreck in the report, "Vegetation, Water and Soil Characteristics of the Louisiana Coastal Region," dated September 1972. Isohalines for the 10-percent exceedance probability for without-project conditions and the Ford line are shown on plate C-9. The Ford line position was taken from a Corps of Engineers report, "Mississippi River Flow Requirements for Estuarine Use in Coastal Louisiana," dated November 1970.

SUPPLEMENTAL FLOW DETERMINATION - BRETON SOUND

C.1.61. To determine the supplemental flows required to maintain the Ford line under 10-percent drought conditions, a volumetric method of routing flows through the estuary was followed. The procedure is given below:

- The probable flow routes of freshwater diverted from the Mississippi River at the Big Mar site were established.

- Zones of influence were established on the basis of the diverted flow routes.

would provide the desired average salinity level for a 10-percent drought year. At the Bayous Lasseigne and Fortier sites, sufficient freshwater could be diverted January through April to maintain desired salinity conditions April through September. At the Davis Pond site, freshwater would have to be diverted January through May. Freshwater diversion at the Oakville and Myrtle Grove sites would require diversion most of the year.

FUTURE SALINITY CHANGES - BRETON SOUND

C.1.59. The Breton Sound area is approximately 666,800 acres and is composed of 333,500 acres of water bodies and 333,300 acres of land areas. It is acknowledged that the Breton Sound area is becoming saltier and that the trend is associated with marsh subsidence and shoreline erosion. Further, it is known that the absence of Missisisppi River flood overflows since the construction of levees and the dredging of canals and waterways have accelerated this trend. Available data in the Breton Sound area that could be used to analyze salinity changes is extremely sparse. The only long-term gaging station for use in this area, Gardner Island, is on the eastern border of Breton Sound along the Mississippi River Gulf Outlet. Other gaging stations data scattered throughout Breton Sound were available but only covered a few monthly periods. Data on subsidence and erosion were limited and unworkable for correlation with salinity. Stage was found to correlate better with salinity than basin runoff and moisture surplus indices. Other factors known or suspected to significantly influence salinities include temperature, winds, and climatic trends extending over periods of several years or decades. The difficulty of quantifying these data into suitable forms for statistical correlation and their undefined time-response factors prohibited their inclusion in this study. Marsh vegetation types are very closely related to salinity levels but the salinity data presently available in the Breton Sound area are too incomplete to quantify.and use for predicting future salinity changes.

time to a value in months representing the apparent lag between points along a primary flow path in the basin while retaining a constant volume represented by its area. It was estimated that the centroid of a hydrograph moving from upstream Mississippi River diversion sites (vicinity of mile 141.0) would take three to four months to reach the lower portion of the basin. In like manner, the centroid of hydrographs with origins in the vicinity of mile 70 and below would take one or two months to reach the lower basin boundary. A simple geometry calculation gave the monthly percentage distribution of outflow at the subbasin boundaries resulting from an average monthly inflow from the Mississippi River.

C.1.58. A series of backwater profiles encompassing the range of predicted tailwater elevations at the outflow end of various conveyance channels and headwater elevations from the Mississippi River was performed using the HEC-2 computer program to define the stage-discharge relationships for each diversion site into the Barataria Basin. It was assumed that the entire volume of freshwater flow would enter from the river during January through April. A tabular format was developed to determine the estimated subbasin VI and VII outflows by month and location for each possible structure and channel considered for the Barataria Basin. The derived monthly flow distribution percentages were used as multipliers to determine incremental subbasin outflows resulting from each month of inflow. These increments were added to determine total monthly outflows. The 3-month average outflows were calculated for each subbasin. These values could then be used in the original sets of regression equations (salinity = dependent variable) to determine with-project salinities. The 3-month average supplemental flows associated with each of the four salinity stations were determined for spring and summer conditions for each of the seven exceedance probabilities, and for both 1980 and 2030 conditions. Ford line salinities were calculated in each case using a linear equation that was a function of salinity at St. Mary's Point and Grand Terre Slip. From the analysis performed, it was determined that a diversion of 10,650 cfs into the Barataria Basin from the Mississippi River

of a line with each curve gave the predicted individual monthly values of an independent variable that would be associated with the station salinities corresponding to the probability represented by that line. The Red River Landing discharges so derived were also converted to monthly mean stages for January through May at the six alternative Mississippi River diversion structure sites. Stage-discharge relationships developed from comparing monthly mean gage heights and flows recorded in the period 1976 through 1979 were used to make the conversions.

- Three-month averages of these associated probability distributions were then prepared for the optimal periods that were determined during the one-on-one correlations.

C.1.56. At this point, the hydrologic and hydraulic analyses merged. The primary design objective had been to determine the sizes of a structure or structures and associated conveyance channels that would deliver a volume of water from the Mississippi River sufficient to reduce the April through June Ford line salinity to 15 ppt in a year whose without-project salinity would be exceeded only 10 percent of the time. The remaining problems would be to determine from the developed data the amounts of water that could be delivered by the design project under a range of pre-existing salinity conditions, and the resultant effects on those salinities.

C.1.57. In earlier investigations of basin moisture surplus variations with respect to salinity levels, characteristic timelag periods between peak moisture surplus values (flows) and depressed salinities, and vice versa, had been estimated. In the absence of any valid flow measurements in the Barataria Basin, a series of dimensionless hydrographs were synthesized that would attenuate with time and distance through the basin and produce effects similar to those indicated by the comparisons. The hydrographs were simulated by progressively flattened triangular shapes whose centroid would advance in

stations/spring and summer 3-month averages). The steps taken to achieve these associated distributions for the particular 3-month periods that had been found to correlate best with station salinities are described below:

- The STAT-1 program was used to determine the statistics (mean, standard deviation, and skewness) for the (1964-1979) 4- or 5-month averge values of discharge, stage and moisture surplus that had been used in the latter group of multiple regression analyses, and for each individual month (January through August or September).

- Probability distributions were developed for each independent variable for each of the time periods.

- Then, 4- or 5-month average variable values that would correspond to 3- to 6-month station salinities having exceedance probabilities of 1, 10, 30, 50, 70, 90, and 99 percent were determined by inserting these predicted salinities into the appropriate terms in each of the latter group of regression equations. Distributions for this and the previous step were calculated for 1980 and 2030 conditions.

- The next step was to define the relationships between each 4- or 5-month average value and its inclusive monthly values. This was accomplished by plotting families of smooth curves that passed through the seven points relating each inclusive monthly value to the multi-month average value having the same exceedance probability, as determined in step 2.

- Lines were drawn that were normal to and that intercepted each (multi-month average) axis at values corresponding to the seven probabilities considered in the third step. The intersections

to occur under those conditions. To do this, the multiple regression program was used in the following manner:

- o Transformations of the independent variables. (Red River Landing Discharge, Basin Moisture Surplus, Grand Isle and Des Allemands Stages) were correlated in turn as dependent variables with salinity at the four stations and time as a fifth independent variable.

- o Optimal equations describing each "dependent" variable in terms of salinity and time were determined. The time coefficients were again reduced by 80 percent, retaining only those salinity stations whose inclusion improved the correlations.

- o Four sets of equations were determined, as follows:

    - o January through April mean discharges and stages correlated with April through September mean salinities

    - o May through August or September discharges and stages correlated with April through September salinities

    - o January through April basin moisture surpluses correlated with April through June salinities

    - o May through August or September moisture supluses correlated with July through September salinities

C.1.55. These equations were developed in order to establish the basis for a probability distribution of each independent variable that would be associated with the previously determined salinity distributions (each of four

salinities occurring at the Ford line (FL) is also shown. Derivation of the FL value is discussed in the next subsection. Graphical representation of the existing (1980) and future salinities (2030) at each station was developed using the average salinity values over the period April through September (plate C-5 through C-8). Isohalines for the 10-percent exceedance probability for 1980 and 2030 without project conditions are shown in plate C-9.

C.1.53. Salinities at the Ford line. To relate changes in salinity levels at the Ford line to freshwater inflows diverted from the Mississippi River, it was necessary to determine the naturally occurring salinities at the Ford line. This was accomplished by interpolating salinity data above and below the Ford line. A linear equation was developed for Ford line salinity in terms of the St. Mary's Point and Grand Terre Slip stations. Although both spring and summer equations were developed, they were so close to being equal that it was decided to use a single equation: Ford line = 4.14 + 0.72 SMP + 0.21 GTS.

SUPPLEMENTAL FLOW DETERMINATION (BARATARIA BASIN)

C.1.54. As previously discussed, higher salinity levels are occurring in estuarine areas and causing unfavorable conditions for productivity. Reversing this trend and maintaining a salinity level of 15 ppt at the Ford line can be accomplished by diverting freshwater into the estuarine area. Having established the existing and future salinity estimated to occur in the basin, it was necessary to determine supplemental freshwater quantities needed to meet the study requirements. In an earlier phase of the Louisiana Coastal Area study, a report on Mississippi River flow requirements for estuarine use in coastal Louisiana identified a preliminary requirement to optimize fish and wildlife resources. The conclusion of that report was that sufficient Mississippi River flow was available to meet the once-in-10-year water needs of the estuary. In developing flows required to maintain the Ford line, it was necessary to determine the relationship among parameter values most likely

TABLE C-1-37

PROBABILITY DISTRIBUTIONS OF SALINITY
Spring and Summer, 1980 and 2030

Exceedance Probability Percent	Salinity (PPT), 1980 Conditions: Spring (April - June) LAF	SMP	FL**	GTS	Summer (July - September) LAF	SMP	FL**	GTS
99	-0.88*	4.12	8.84	8.26	-0.11*	6.86	12.52	16.37
90	0.34	7.69	12.32	12.58	0.82	9.38	14.79	18.54
70	1.51	10.38	14.85	15.43	1.78	11.70	16.80	20.15
50	2.47	12.28	16.61	17.27	2.61	13.55	18.36	21.28
30	3.59	14.23	18.37	18.98	3.59	15.68	20.14	22.43
10	5.46	17.11	20.93	21.27	5.29	19.14	22.99	24.12
1	8.56	21.23	24.49	24.11	8.20	24.79	27.56	26.51

Exceedance Probability Percent	Salinity (PPT), 2030 Conditions: Spring (April - June) LAF	SMP	FL**	GTS	Summer (July - September) LAF	SMP	FL**	GTS
99	-0.58*	4.32	8.91	7.91	0.44	7.61	12.75	14.92
90	0.64	7.89	12.39	12.23	1.37	10.13	15.02	17.09
70	1.81	10.58	14.92	15.08	2.33	12.45	17.03	18.70
50	2.77	12.48	16.68	16.92	3.16	14.30	18.60	19.83
30	3.89	14.43	18.44	18.63	4.14	16.43	20.38	20.98
10	5.76	17.31	21.00	20.92	5.84	19.89	23.22	22.67
1	8.86	21.43	24.56	23.76	8.75	25.54	27.79	25.06

*Considered as zero

**Computed from Derived Equation, FL = 4.14 + 0.72SMP + 0.21 GTS

TABLE C-1-36

MULTIPLE REGRESSION EQUATIONS[1/]

(Salinity as Dependent Variable)

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1. $LAF6 = 17.64 - 2.88 \ln RRL4 + 41.0e^{-.00069M,S66} + .008TY$
2. $LAF9 = 16.21 - 2.58 \ln RRL5 + 3.71e^{-.00075MS67} + .013TY$
3. $SMP6 = 40.30 - 5.90 \ln RRL5 + 10.51e^{-.00028MS66} + .009TY$
4. $SMP9 = 25.79 - 4.17 \ln RRL6 + 15.53e^{-.00023MS67} + .018TY$
5. $GTS6 = 79.76 - 8.74 \ln RRL6 - 0.32e^{-.000035MS74} - 3.66G18 - 7.61e^{-.37DA6}$
$- .007TY$
6. $GTS9 = 18.94 - 3.97 \ln RRL8 + 26.93e^{-.000039MS78} - .029TY$

TY = Time, Year since 1964

Numbers behind each variable represent the month of year that is final month of 3-month average

LAF = Lafitte (PPT)

SMP - St. Mary's Point (PPT)

GTS = Grand Terre Slip (PPT)

MS67 = Moisture Surplus, (CFS) Month of year and subbasin

GI = Grand Isle Stage (Ft. NGVD)

DA = Des Allemands Stage (Ft. NGVD)

RRL = Red River Landing Discharge (1000 CFS)

[1/] Equations for Grand Isle Platform are not shown.

calculated values compared to those observed would be at a minimum). The significance of each variable was determined by comparison to an established confidence level (CL) value. The equations generated included only those independent variables that were found to be significant according to the CL criteria and that improved the correlation, that is, reduced the variation of the dependent variables. Output of the program includes: basic statistics for each variable (mean, standard deviation, minimum, and maximum), correlation matrix, determination coefficient, standard error, beta weight, and tabulated observed and calculated values of the dependent variable, along with error, percent error, and cumulative error squared.

C.1.51. From the regression analysis, it was observed that the time variable correlation with salinity was usually low and produced in- compatible salinity predictions between the selected stations. After a series of trial calculations using various percentages of the calculated time coefficients, it was decided that an amount equal to 20 percent of the calculated time coefficient value produced compatible results.

C.1.52. The equations derived are displayed in table C-1-36. Existing (1980) and future (2030)* salinity levels at the stations were estimated through the use of the time-variable coefficient. When multiplied by 16, the coefficient of time would represent the change in salinity levels between 1964 (base year) and 1980. When multiplied by 66, the coefficient of time would represent the total change between 1964 and 2030. Probability distributions were obtained by adding or subtracting the computed change in salinity to the base probability distribution. The resultant 1980 and 2030 probability distributions are shown in table C-1-37. The probability distribution of

*The hydraulic analysis study period (1980-2030) differs from the overall study period (1985-2035). The 2030 conditions are considered as nearly reflecting 2035 conditions.

shown on plate C-14. Either of the three upriver sites is acceptable. However, based purely on hydraulic considerations, the available stages in the river, and the slope of the terrain, the site at mile 141.1 is a better diversion site.

STRUCTURAL HYDRAULICS

C.1.66. Concrete culvert boxes were selected as the structures to divert freshwater from the Mississippi River to the coastal area. The structures were designed by assuming a velocity through the structure of about 6 feet per second, which yielded a cross sectional area capable of discharging the required amount of fresh water at each location. Several depths were tried in conjunction with a 20-foot width to determine the number of concrete culverts needed at each height to yield the required cross sectional area. The river stage for each site was taken as the one most likely to be equalled or exceeded during a 10-percent exceedance high salinity year. The tailwater elevations at the structures were found by using the HEC-2 program to route the freshwater diversion upstream. The backwater computations assumed a Manning's roughness coefficient of 0.03, a contraction coefficient of 0.7, and an expansion coefficient of 0.5. Hydraulic characteristics of diversion structures are described in the Design and Cost Section of this appendix.

CHANNEL HYDRAULICS

C.1.67. Various combinations of channel dimensions, that is, slopes, bottom widths, and depths, were evaluated to yield the optimum combination in terms of minimal channel excavation and levee building. Channels having a 1 on 3 sideslope and varying bottom widths were selected because they could convey the design flows corresponding to computed available hydraulic heads. With the HEC-2 computer program, the design discharges were routed upstream to the structure, starting with the corresponding stage of the receiving body of water. The diversion channel dimensions are presented in the Design and Cost Section of this appendix. (See Table C-2-1).

IMPACTS OF FRESHWATER DIVERSION

EFFECTS ON NAVIGATION

C.1.68. Under the tentatively selected plan, a maximum of 17,300 cfs will be diverted from the Mississippi River during the 10-percent drought year in the months of January, February, March, April, and May. Local drought years have a significant correlation with Mississippi River discharge. Average monthly discharges in the river that occur simultaneously with the 10-percent drought condition are 241,000 cfs in January, 249,000 cfs in February, 362,000 cfs in March, 345,000 cfs in April, and 329,000 cfs in May. The average five-month discharge is 309,000 cfs. For these flows, the tip of the saltwater wedge is maintained below Head of Passes (mile 0 of the Mississippi River).

C.1.69. The effect on shoaling in the river immediately downstream of the diversion site will most probably be insignificant because of the naturally existing deep water in the river. The effect of the diversion on shoaling in Southwest Pass can be calculated from the reduction in average annual discharge in the Mississippi River.

C.1.70. Specifically, the currently envisioned diversion of freshwater to Barataria and Breton Sound Basins would be:

- 10 percent drought year - 17,300 cfs
- 20 percent drought year - 15,000 cfs
- 30 percent drought year - 13,600 cfs
- 40 percent drought year - 12,000 cfs
- 50 percent drought year - 10,000 cfs

- o 60 percent drought year - 9,000 cfs

- o 70 percent drought year - 8,000 cfs

- o 80 and 90 percent drought year - 0 cfs

- o long-term average discharge, January through May - 9,500 cfs

This quantity, multiplied by the percent of the year in which the discharge occurs, is further reduced to about 3,200 cfs per year removed from the average annual flow of 463,000 cfs per year. This represents a 0.7 percent reduction in the average annual discharge of the river below the Carrollton Gage (mile 103.0).

C.1.71. The Mississippi River and Southwest Pass have a naturally maintained cross section that is directly proportional to the average annual discharge of the river and pass. Any increase in dredging is assumed to be proportional to the decrease in the long term average annual discharge or 0.7 percent of the annual dredging volume in Southwest Pass, (0.7 percent of 16 x 10 cubic yards) 112,000 cubic yards per year.

EFFECTS ON FLOOD CONTROL

C.1.72. The diversion channels that convey the water from the Mississippi River to receiving water bodies were designed to convey the water within banks. However, levees would be constructed along the diversion channels to provide an added factor of safety against flooding. These channels were generally located to avoid interference with local drainage systems. Where interference could not be avoided, provisions were made to restore equivalent drainage facilities as a part of the project. At the Bayou Lasseigne site, the level of Lac Des Allemands could be raised a maximum of a few tenths of a

foot by the diverted river water. At the Davis Pond site, the water levels within the impoundment area north of Lake Cataouatche between Bayou Verret and the Willowdale subdivision would be raised as much as two feet to elevation 3.0 feet NGVD during diversions of the design flow of 10,650 cfs. At the Big Mar site, the water level of Big Mar would be raised one foot to elevation 2.0 feet NGVD during peak diversions. The Davis Pond impoundment would retain the design flow for about 24 hours. At Big Mar, the design flow would be retained for about 8 hours. Outflow from Davis Pond and Big Mar would be over weirs and low areas in the levees.

C.1.73. The diverted flow would raise the mean water levels of the receiving water bodies, but would have an insignificant impact on the mean high water levels. Stages in the various water bodies adjacent to the impoundment areas may be raised by 1 to 3 tenths of a foot. At the Davis Pond site, the diversion channel is designed to convey 10,650 cubic feet per second (CFS) from the Mississippi River by way of a leveed channel that would run under Louisiana Highway 18, the Texas and Pacific Railway, the Missouri Pacific Railway, and U.S. Highway 90 and then 1,000 feet southeast into the impoundment area south of Highway 90. The levees for this channel are designed with 4 feet of freeboard above the flowline. This freeboard allowance is also used for many of the Mississippi River mainline levees. The flowline in the diversion channel was determined by standard backwater computations from an assumed elevated stage in the impoundment area of 3.0 feet NGVD. The diverted water would be detained in the impoundment area for about 1 day. The impoundment area would be leveed on the western, northern, and eastern sides. The south side would be the natural bank elevation of Lake Cataouatche. All these impoundment area levees have been set 2 feet above the maximum water level of 3.0 feet NGVD. On the south side, the natural bank of Lake Cataouatche is about 3.0 feet NGVD. The discharge from the impoundment area was designed using 1 1/2 feet of head loss over 4 weirs, each with a sill 250 feet long at -1.0 NGVD. An additional weir has been incorporated in the design to improve the feasibility of operations and increase the outflow

capacity by 25 percent to insure that the ponding area cannot exceed its design water level. The water level of Lakes Salvador and Cataouatche has a normal tide range of 0.3 foot around a mean level of 1.0 foot NGVD. Flow between the two lakes is conveyed by Bayous Bardeaux and Couba. The cross-sectional area of these bayous were determined by a field sounding survey. In Bayou Bardeaux the minimum cross section is 3,700 square feet, in Bayou Couba, 5,400 square feet. (Plates 15 and 16). Using these data along with other office information, backwater computations were made using HEC-2 to develop rating curves for Bayous Bardeaux and Couba. (Plates 17 and 18). Based on these rating curves, with stages of 1.0 foot in Lake Salvador and 1.23 feet in Lake Cataouatche, Bayou Bardeaux can convey 4,650 CFS and Bayou Couba can convey 6,000 CFS into Lake Salvador, a total of 10,650 cfs, the project design flow. These computations were made using the mean tidal elevation of the two lakes. As long as the stages remain between elevation 0.0 and the top of the bank, a differential stage of 0.23 foot would allow conveyance of the design flow from Cataouatche to Salvador. Once the stage rises above the bank line, the differential stage will decrease. The increase in stage in Lake Salvador caused by the addition of 10,650 cfs from the Mississippi River would be negligible. The conveyance channels feeding Lake Salvador from Barataria Bay are much larger than Bayous Bardeaux and Couba since the channels connecting the lake and the bay have to convey not only the normal tidal prism of Lake Cataouatche but also the tidal prism of Lake Salvador. As an upper limit, since Lake Salvador is three times as large as Lake Cataouatche, the increase in stage in Lake Salvador should not exceed .08 foot, or one third the increase in stage in Lake Cataouatche. In summary, if the existing elevation in Lake Salvador is 1.0 foot, the maximum estimated water elevation rise in this lake due to diverted river water would be .08 foot. Adding the 0.23-foot stage differential between Lakes Salvador and Cataouatche plus the 1.5 feet head for the weirs feeding into Lake Cataouatche, would yield a stage of 2.81 feet in the marsh south of Highway 90. This stage of 2.81 feet agrees closely with the assumed stage of 3.0 feet NGVD with which the compuations were begun.

SEDIMENTATION

C.1.74. The diversion structures were designed to convey flows with velocities of about 6 fps. The outflow channels were designed for velocities of 2 to 3 fps. Given these design flow velocities, sedimentation is not projected to be significant in the channels. However, based on the percentage of the Mississippi River flow diverted at each site on an annual basis, easements of sufficient size were provided to contain about 10 percent, 5 percent, and 1 percent of the diverted sediment load along the outflow channels at Bayou Lasseigne, Davis Pond, and Big Mar, respectively. The diverted sediment load was computed as the percent of the river's flow times one-half the concentration of the sediment load in the river. The reduction in sediment load was based on the fact that these structures will be diverting water from the top 25 percent of the water column. Based on the average annual sediment load in the river of 189 million short tons and the percent of the average annual river flow diverted at each site, the Bayou Lasseigne site will divert a maximum of 21 million tons of sediment in the 50-year project life, Davis Pond will divert 25 million tons, and Big Mar will divert 13 million tons.

C.1.75. When the diverted river water reached the receiving water bodies, velocities would decrease resulting in significant sedimentation. Receiving water bodies for water diverted at Bayou Lasseigne, Davis Pond, and near Caernarvon are Lac Des Allemands, Davis Pond impoundment, and Big Mar, respectively. Deltas are expected to be formed in these receiving water bodies. In Lac Des Allemands the delta could cover about 3 square miles of lake bottom to a thickness of 3 feet during the 50-year project life. This area is about 12 percent of the lake bottom. In the Davis Pond area, the delta will cover about 4 square miles with a top elevation of about 2 1/2 feet NGVD and a thickness of 1 to 4 feet. In Big Mar, the sediment could cover the whole lake bottom to a depth of 2 1/4 feet during the project life. These computations assume 90 percent, 95 percent, and 99 percent retention of the

sediment entering Lac des Allemands, Davis Pond impoundment, and Big Mar, respectively. The amount of sediment expected to be retained in the receiving water body may vary from 60 to 99 percent depending on the sediment composition (sand, silt, and clay) and the discharge in any year. The shape of the emerging delta was predicted using methodology similar to that used to predict the emerging delta in Atchafalaya Bay. That is, the deltas were allowed to prograde in uniform segments longitudinally and laterally over a depth determined by the bottom profile. Each unit of growth in the longitudinal direction was accompanied by a growth of one-half in the lateral direction on each side of the projected centerline. Existing topography was used to further shape the edges of the deltas along existing physical features of the receiving water bodies.

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Section 2. DESIGN AND COST ESTIMATES

GENERAL

C.2.1. This section contains design information and cost estimates on the various alternatives for diverting Mississippi River flow to the wetlands and water bodies in the study area. Typical plans of improvement considered at each site included a control structure adjacent to the river, conveyance channels, and appurtent works. At the Davis Pond site, and to encourage overland flow through the marshes.

C.2.2. Diversion flows and structure sites were determined from hydrologic and hydraulic analyses discussed in the previous section. Structural designs are based on applicable US Army Corps of Engineers Design Manuals and other applicable building codes and manuals recognized by the engineering profession. No soil borings were made specifically for this study. Available soil borings in the study area and geological publications were used to the maximum extent practicable to determine foundation requirements. Geological descriptions of the subsurface are based on the publications "Distribution of Soils Bordering the Mississippi from Donaldsonville to Head of Passes," Tech. Report No. 3-601, June 1962, Dr. Charles R. Kolb, and "Geology of the Mississippi River Deltaic Plain - Southeastern Louisiana," Tech. Report No. 3-483, July 1958.

PROJECT SITE EVALUATION

C.2.3. During the preliminary evaluation, 21 alternative locations along the Mississippi River were identified as diversion sites. The engineering reconnaisance analysis consisted of preliminary design of structures, channels, and associated works necessary to use the sites. The analysis determined the hydraulic efficiency of each site,

identified design and relocation problems, evaluated site performance in achieving study objectives, and developed a preliminary cost estimate for comparison of site economics. A list of the 21 sites and the preliminary evaluation and assessment to determine sites for further study is in the Plan Formulation Appendix. The interdisciplinary planning team determined that six sites warranted detailed investigations after considering all factors affecting site selection.

The sites are:

Bayou Lasseinge (Mississippi River mile 141.1 AHP)
Bayou Fortier (Mississippi River mile 132.0 AHP)
Davis Pond (Mississippi River, mile 118.4 AHP)
Oakville (Mississippi River mile 70.4 AHP)
Below Caernarvon at Big Mar (Mississippi River mile 81.5 AHP)
Myrtle Grove (Mississippi River mile 58.7 AHP)

The diversion sites are shown on plates C-19 thru C-24.

DESIGN CRITERIA

HYDRAULICS

C.2.4. Hydrologic and hydraulic studies discussed in Section 1 determined the magnitude of supplemental water required and have shown that supplemental freshwater must be diverted to the wetlands during January, February, March, April, and May in order to be effective in maintaining the desired salinity conditions during April through September. Stage-discharge relationships for these months were established for 10 stations along the Mississippi River between Alliance (mi. 62.5) and College Point (mile 157.4). Stages at the six diversion sites were determined using water level profiles plotted from the established stage-discharge relationships. Based on the expected stages

and supplemental water requirements, several types of diversion structures were considered: siphons, pumps, tainter gates, and multi-cell concrete box culverts with steel vertical lift gates. Siphons were considered impractical due to large head losses and the large size of siphons required. Pumps were too costlv. Both tainter gates and multi-cell concrete box culverts were determined to be suitable, but multi-cell concrete box culverts were selected to be used at the diversion sites because they require less modification to levee alinement and less excavation during construction, and are generally less expensive. In addition, culverts placed in the Mississippi River levee at the Bayous Lasseigne and Fortier and Big Mar sites would eliminate the need for an extensive pile foundation to prevent settlement. The existing levee acts as a preload and would have to be degraded when the diversion site is in place. Interim flood protection during construction at the sites would be provided by cofferdam. The limited space between the levee and the river at the Oakville and Myrtle Grove sites prevented placing the culvert structure in the existing levee. The structures would be placed in levee setbacks and pile foundation may be required.

C.2.5. The multi-cell concrete box culvert structures were designed for a velocity through the structure of about 6 feet per second (FPS) assuming that a one-cell culvert is 20 feet wide (15 feet wide at Davis Pond), several depths of structure were analyzed to determine the number of concrete culverts required to yield the maximum design flow. Several maximum design flows were considered at each site. Backwater computations were made to determine head losses through the culverts and optimum channel dimensions, i.e., slopes and bottom widths, with channel velocities of 2 to 3 fps. The analyses showed that the invert of the structures should be placed at the maximum elevation to accommodate the structures barely flowing full. This elevation will provide sufficient supplemental water to the marshes to maintain the Ford line at a desired location during a drought with a recurrence interval of once every ten years.

FOUNDATIONS AND MATERIALS

C.2.6. Foundation sediments at the five diversion sites consist of Holocene Mississippi River aluvium underlain by Pleistocene deltaic material. Batture dimensions are sufficiently wide to support an earthen riverside cofferdam at the Bayou Lasseigne, Bayou Fortier, Davis Pond, and Big Mar sites. The batture at the Oakville and Myrtle Grove sites is narrow and the structures would be located on the land side of the levee. At the Bayou Lasseigne site, surface elevations are approximately +15 to +20 feet NGVD. Interdistributary material consisting of fat clays with some silt layers and some sands is below the natural levee. At about elevation -40 feet NGVD, stiff Pleistocene clays with some silt layers exist. These conditions indicate the necessity for a wellpoint-type pressure relief system at the diversion site to control underseepage, excessive hydrostatic pressure, and to insure excavation slope stability.

C.2.7. Surface elevations at the Bayou Fortier site are approximately +10 to +12 feet NGVD. No borings have been made in the immediate area. However, geological file data and one boring taken approximately 1 mile from the site indicate that the surficial material is natural levee deposits composed of fat and lean clays with layers of silts to about +2 feet NGVD. The natural levee deposits are underlain by point bar material consisting of silts, silty sands, and sands with layers of clay. It is estimated that the Pleistocene surface will be encountered at elevation -135 (+5) NGVD. These conditions will require an extensive pressure relief system at the diversion site. Depending on actual site conditions, a system of several rings of wellpoints may be required. Extensive erosion protection is required at the diversion structure due to the nature of the soils.

C.2.8. Surface elevations at the Davis Pond site vary from about +10 to +15 feet NGVD near the diversion site to 0 to +1 NGVD in the Davis Pond impoundment. No borings have been made in the immediate area. Published data indicate that surface materials adjacent to the Mississippi River are pointbar sediments and natural levee deposits. The pointbar sediments consist predominantly of silts and fine, silty sands. The natural levee sediments are composed primarily of soft to medium clays with lenses of silt scattered throughout. An inland swamp environment would be encountered from the edge of the natural levee deposits adjacent to the Mississippi River to approximately midway between the river and Lake Cataouatche. Freshwater marsh sediments would be encountered for the remainder of the distance to the lake. The surface of the swamp and marsh sediment lie just above NGVD. The thickness of these deposits varies from 0 feet thick at the margin of the natural levee deposits to approximately -60 feet NGVD. Underlying the deltaic deposits lie resistant pleistocene sediments to a depth of several hundred feet. The general soil conditions near the Mississippi River levee indicate good resistance to seepage and low susceptibility to consolidation settlement. Depending on actual site conditions, a wellpoint relief system may be required. Erosion protection would be required at the diversion structure.

C.2.9. At the Oakville site, surface elevations are approximately +3 to +5 feet NGVD. Geologic file data and borings in the area indicate that the surficial material is natural levee deposits consisting of fat and lean clays with layers of silt to about elevation -2 feet NGVD. The natural levee deposits are underlain by point bar material consisting of silts, silty sands, and sands with thin layers of clay to about elevation -35 NGVD. Below elevation -35 NGVD, the prodelta clays composed of homogeneous fat clays of medium consistency are encountered. The Pleistocene surface was not penetrated by borings; however, it is estimated to be at about elevation -100 feet NGVD. A

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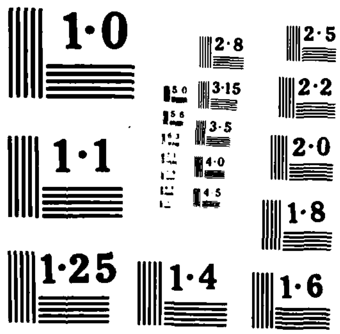
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wellpoint pressure relief system at the diversion site is required to control underseepage and excessive hydrostatic pressure. Extensive erosion protection is required at the diversion structure.

C.2.10. Surface elevations at the Big Mar site are about +4 to +7 feet NGVD. Natural levee deposits of fat and lean clays with layers of silts make up the surficial material to about elevation -2 feet NGVD. Between -2 feet NGVD and -110 feet NGVD , undifferentiated deltaic plain material consisting of fat and lean clays are encountered below elevation -110 NGVD. An extensive pressure relief system is not required but the extent and location of silt layers may require a wellpoint pressure relief system to insure excavation slope stability.

C.2.11. At the Myrtle Grove site, surface elevations are approximately +3 to +6 feet NGVD. Geologic file data and borings in the area indicate surficial material to be natural levee deposits of soft to stiff clays with lenses and layers of the silt . This material is present to elevation -8 NGVD. Below elevation -8 feet NGVD to about elevation -20 feet NGVD marsh deposits of very soft clays with organic material and peat exist. The marsh deposits are underlain by an interdistributary deposit of very soft to soft clays with lenses and layers of silt to about elevation -60 feet NGVD. Below the marsh deposits, prodelta clays of homogenous fat clays of medium consistency are encountered to about elevation -104 feet NGVD. The prodelta clays extend down to nearshore deposits of sand with shell and shell fragments and lenses and layers of clays. At about elevation -104 feet NGVD, the top of the Pleistocene surface is found. These site conditions indicate the necessity of a wellpoint pressure relief system to control underseepage and excessive hydrostatic pressures.

SITE DESIGN AND COSTS

STRUCTURE AND CHANNELS

C.2.12. Since the diversion structures and associated works are similar in design, it is not necessary to discuss each diversion site in detail. As previously stated, the diversion structures would be reinforced concrete multi-cell box culverts with steel vertical lift gates. The number of cells vary with the flow requirements. Pertinent project site features are shown in table C-2-1. The diversion structures at Bayou Lasseigne and Oakville would have multiple 12' x 20' cells. The diversion structure at Bayou Fortier would have multiple 13' x 20' cells. At the Davis Pond site , the diversion structure would have multiple 15' x 15' cells. Structures at Bayous Lasseigne and Fortier would be 200 feet long with invert elevations at -4.0 NGVD and -6.0 NGVD, respectively. At the Big Mar and Myrtle Grove sites, the diversion structures would have multiple 5' x 20' and 13' x 20' cells, respectively. The diversion structures at Big Mar, Oakville, and Myrtle Grove would be 100 feet long with invert elevations of -3.0, -8.0, and -10.0 NGV, respectively. The diversion structure at Davis Pond would be 240 feet long with an invert elevation at -10.0 NGVD. At all structures, an electric motor and gear reducer mounted on pedestals would raise the vertical lift gates on two tandem vertical threaded steel stems per gate.

C.2.13. It is estimated that it will take 2 years to construct each diversion structure. Construction methods at the Bayou Lasseigne, Bayou Fortier, Davis Pond, and Big Mar diversion sites would include using an earthen cofferdam around the structure. The Oakville and Myrtle Grove structures may be founded on concrete, steel-reinforced piles. A relief well dewatering system will be used at the five sites. Temporary bypasses for railroads and roads would be provided during construction to

TABLE C-2-1

PERTINENT PROJECT SITE FEATURES

Diversion Sites	Maximum Design Flow (CFS)	Mississippi River Design Stage	Length of Control Structure (FT)	No. of Culverts	Culvert Invert elevation (NGVD)	Inflow Channel Length (FT)	Inflow Channel Bottom Width (FT)	Inflow Channel Bottom Elevation (NGVD)	Inflow Channel Side Slopes	Outflow Channel Length (FT)	Outflow Channel Bottom Width (FT)	Outflow Channel Bottom Elevation (FT)	Outflow Channel Side Slopes
Bayou	10,650	9.6	200	6-12'x20'	-4.0	560	160 to 200	-5.0	IV on 3H	32,080	120 to 200	-5.0 to -12.0	IV on 3H
Lasseigne	7,100	9.6	200	4-12'x20'	-4.0	560	100 to 120	-5.0	IV on 3H	32,080	80 to 160	-4.5 to -11.5	IV on 3H
	5,325	9.6	200	3-12'x20'	-4.0	560	80 to 100	-4.0	IV on 3H	32,080	60 to 120	-4.0 to -10.5	IV on 3H
	3,550	9.6	200	2-12'x20'	-4.0	560	60	-4.0	IV on 3H	32,080	40 to 80	-3.5 to - 9.5	IV on 3H
Bayou	10,650	8.6	200	6-13'x20'	-6.0	5,900	200	-6.0	IV on 3H	30,220	160 to 240	-5.0 to -14.0	IV on 3H
Fortier	7,100	8.6	200	4-13'x20'	-6.0	5,900	120	-6.0	IV on 3H	30,220	100 to 200	-5.0 to -11.0	IV on 3H
	5,325	8.6	200	3-13'x20'	-6.0	5,900	100	-5.5	IV on 3H	30,220	80 to 160	-5.0 to -10.5	IV on 3H
	3,550	8.6	200	2-13'x20'	-6.0	5,900	60	-5.5	IV on 3H	30,220	60 to 100	-5.0 to -10.0	IV on 3H
Davis Pond	10,650	7.0	240	6-15'x15'	-10.0	520	200	-10.0	IV on 3H	11,250	200	-12.0 to -10.0	IV on 3H
Oakville	5,325	4.7	100	4-12'x20'	-8.0	160	120	-8.5	IV on 3H	44,720	120 to 160	-10.5 to -13.0	IV on 3H
	3,550	4.7	100	2-12'x20'	-8.0	160	60	-9.5	IV on 3H	44,720	60 to 120	-11.0 to -13.0	IV on 3H
Big Mar	6,600	5.6	100	9-5'x20'	-3.0	800	200	-3.0	IV on 3H	8,100	180	-3.0 to -6.0	IV on 3H
	4,400	5.6	100	6-5'x20'	-3.0	800	130	-3.0	IV on 3H	8,100	130	-3.0 to -6.0	IV on 3H
	2,200	5.6	100	3-5'x20'	-3.0	800	60	-3.0	IV on 3H	8,100	60	-3.0 to -6.0	IV on 3H
Myrtle Grove	5,325	4.2	100	4-13'x20'	-10.0	500	120	-10.5	IV on 3H	43,600	50 to 225	-13.0 to -15.0	IV on 3H
	3,550	4.2	100	2-13'x20'	-10.0	500	60	-11.6	IV on 3H	43,600	50 to 225	-13.0 to -15.0	IV on 3H

accommodate traffic. The railroads and roads would be replaced to the appropriate standards and criteria when construction of the diversion structure is essentially complete. Summaries of estimated first costs for the diversion structures are shown in tables C-2-2 through C-2-7. Detailed designs of the diversion structures and associated works are shown on plates C-25 through C-30.

C.2.14. Reinforced concrete multi-cell box culverts were used under major highways and railroad crossings at the Bayou Lasseigne, Bayou Fortier, and Big Mar sites. All culverts would have the same capacities as the diversion structures. Culverts 40 feet long would be constructed under the Texas and Pacific Railroad at the Bayou Lasseigne and Bayou Fortier diversion sites to pass flows from the structures. At the Big Mar site, a 100-foot long culvert would be constructed under Louisiana Highway 39 and the Southern Railroad to pass flows from the Big Mar structure. Steel deck bridges would be used at the Oakville and Myrtle Grove sites to pass Louisiana Highway 23 and the New Orleans and Lower Coast Railroad over the diversion channels. At the Davis Pond site, steel deck bridges would be used to pass US Highway 90, Southern Pacific, and Texas and Pacific railroads.

C.2.15. The guide levees associated with the Davis Pond diversion channel and overflow area will intercept drainage patterns in the project area. Generally, drainage south of the Mississippi River levee follows a southeast direction. The area north of U.S. Highway 90 flows to drainage canals that parallel the south side of the highway. The diversion channel and associated guide levees will bisect the area north of U.S. Highway 90. The area east of the diversion channel and north of U.S. Highway 90 will continue to discharge to Bayou Verret via the drainage canal south of the highway. Drainage in the area west of the diversion channel and north of U.S. Highway 90 collects in the drainage canal south of the highway and discharges to the swamp area south of the

TABLE C-2-2

SUMMARY OF PERTINENT DATA AND FIRST COSTS FOR DIVERSION STRUCTURE

Bayou Lasseigne Site, Mile 141.1

Cost Acct. No.	Item	Unit / Unit Price	Maximum Design Flow (CFS) 10,650	7,100	5,325	3,550
15.	Diversion Structure					
	Mobilization and Demobilization	Lump Sum	$100,000	$100,000	$100,000	$100,000
	Clearing and Grubbing	Lump Sum	$ 75,000	$75,000	$ 75,000	$ 75,000
	Excavation					
	Excavation (Levee, Structures and Dam)*	Cubic Yard	325,000	274,330	254,800	235,320
		$2.00	$650,400	$548,700	$509,600	$470,600
	Backfill (Levee, Structure, and Dam)*	Cubic Yard	215,600	184,830	175,380	165,922
		$5.00	$1,078,000	$924,200	$876,900	$829,600
	Backfill (Reusable)	Cubic Yard	91,400	84,650	78,270	71,920
		$3.00	$ 274,100	$254,000	$234,800	$215,700
	Relief Wells (Dewatering System)	Each	6	4	3	2
		$35,000	$210,000	$140,000	$105,000	$ 70,000
	Foundation Preparation Stabilization Slab	Cubic Yard	600	420	320	230
		$175	$105,000	$ 73,500	$ 56,000	$ 40,200
	Fertilizing and Seeding	Acres	1.6	1.2	0.9	0.7
		$500	$ 800	$ 600	$ 500	$ 400
	Environmental Protection	Lump Sum	$ 46,600	$ 35,800	$ 30,100	$ 24,900
	Structure					
	Mass Concrete For Structure	Cubic Yard	14,000	10,220	8,120	6,150
		$325	$4,579,200	$3,321,500	$2,639,000	$1,998,800
	Gates and Associated Items Vertical Lift Gates	Each	6	4	3	2
		$125,000	$750,000	$500,000	$375,000	$250,000
	Walkway For Operating Gate	Each	6	4	3	2
		$3,000	$18,000	$12,000	$9,000	$6,000
	Reinforcing Steel	Pounds	1,410,200	1,030,000	818,000	619,000
		$0.60	$846,100	$618,000	$490,900	$371,400
	Erosion Protection Riprap	Ton	2,330	1,605	1,300	1,000
		$25	4	4	4	4
			$58,000	$40,100	$32,500	$25,000
	Subtotal		$8,791,200	$6,643,400	$5,534,300	$4,477,600
	Contingencies (+25%)		$2,197,800	$1,660,600	1,383,700	1,121,400
	Subtotal		$10,989,000	$8,304,000	$6,918,000	$5,599,000
	E&D (+12%)		1,318,000	997,000	830,000	673,000
	S&A (+10%)		1,099,900	830,000	692,000	560,000
	TOTAL		$13,406,000	$10,131,000	$8,440,000	$6,832,000
	TOTAL ROUNDED		$13,400,000	$10,100,000	$8,440,000	$6,830,000

*Includes earthen cofferdam

TABLE C-2-3

SUMMARY OF PERTINENT DATA AND FIRST COSTS FOR DIVERSION STRUCTURE

BAYOU FORTIER SITE, Mile 132.0

Cost Acct. No.	Item	Unit / Unit Price	Maximum Design Flow (CFS) 10,650	7,100	5,325	3,550
15.	Diversion Structure					
	Mobilization and Demobilization	Lump Sum	$100,000	$100,000	$100,000	$100,000
	Clearing and Grubbing	Lump Sum	$ 75,000	$ 75,000	$ 75,000	$ 75,000
	Excavation					
	Excavation (Levee, Structures & Dam)*	Cubic Yard	325,200	274,300	254,800	235,320
		$2.00	$650,400	$548,700	$509,600	$470,600
	Backfill (Levee, Structure & Dam)*	Cubic Yard	215,600	184,830	175,380	165,922
		$5.00	$1,078,000	$924,100	$876,900	$829,600
	Backfill (Reusable)	Cubic Yard	91,360	84,650	78,270	71,920
		$3.00	$274,100	$254,000	$234,800	$215,700
	Relief Wells (Dewatering System)	Each	6	4	3	2
		$35,000	$210,000	$140,000	$105,000	$ 70,000
	Foundation Preparation					
	Stabilization Slab	Cubic Yard	600	420	320	230
		$175	$105,000	$ 73,500	$ 56,000	$40,200
	Fertilizing and Seeding	Acres	1.60	1.20	0.90	0.70
		$500	$800	$600	$400	$400
	Environmental Protection	Lump Sum	$ 45,000	$ 34,200	$ 28,700	$ 23,400
	Structure					
	Mass Concrete For Structure	Cubic Yard	14,090	10,220	8,120	6,150
		$325	$4,579,300	$3,321,500	$2,639,000	1,998,800
	Gates and Associated Items					
	Vertical Lift Gates	Each	6	4	3	2
		$125.000	$750,000	$500,000	375,000	$250,000
	Walkway for Operating Gates	Each	6	4	3	2
		$3,000	$ 18,000	$ 12,000	$ 9,000	6,000
	Reinforcing Steel	Pound	1,410,200	1,030,000	818,000	619,000
		$0.60	$846,100	$618,000	$ 490,800	$371,400
	Erosion Protection Riprap	Ton	2,300	1,605	1,300	1,000
		$25	$ 58,300	$ 40,100	$ 32,500	25,000
	Subtotal		$8,790,000	$6,641,700	$5,532,700	4,476,100
	Contingencies (+25%)		2,197,000	1,660,300	1,382,300	1,118,900
	Subtotal		$10,987,000	$8,302,000	$6,915,000	$5,595,000
	E&D (+12%)		1,319,000	996,000	830,000	671,000
	S&A (+10%)		1,099,000	830,000	692,000	560,000
	TOTAL		$13,405,000	$10,128,000	$8,437,000	$6,826,000
	TOTAL ROUNDED		$13,400.000	$10,100,000	$8,440,000	$6,830,000

*Includes earthen cofferdam

TABLE C-2-4

SUMMARY OF PERTINENT DATA AND FIRST
COSTS FOR DIVERSION STRUCTURE

DAVIS POND SITE, MILE 118.4

Cost Acct. No.	Item	Unit / Unit Price	Maximum Design Flow (CFS) 10,650
15.	Diversion Structure		
	Mobilization and Demobilization	Lump Sum	$100,000
	Clearing and Grubbing	Lump Sum	75,000
	Excavation		
	Excavation (Levee Structures and Dam)*	Cubic Yard $2.00	197,150 $394,300
	Backfill (Levee, Structure, and Dam)*	Cubic Yard $5.00	63,956 $319,780
	Backfill (Reusable)	Cubic Yard $3.00	17,604 $ 52,812
	Relief Well (Dewatering System)	Each $35,000	6 $210,000
	Foundation Protection Stabilization Slab	Cubic Yard $175	680 $119,000
	Environmental Protection	Lump Sum	$ 75,000
	Structure		
	Mass Concrete for Structure	Cubic Yard $325	11,962 $3,887,650
	Reinforcing Steel	Pounds 0.60	1,196,200 $717,720
	Gates and Associated Items Vertical Lift Gates	Each $100,000	6 $600,000
	Walkway for Operating Gate	Each $3,200	6 $ 19,200
	Timber Stoplog Weirs	Each $165,000	5 $825,000
	Pumps: 1-100 & 1-260 CFS, & related drainage work	Lump Sum	$1,658,000
	Erosion Protection Riprap	Tons $175	1,458 255,150
	Inflow Channel Riprap	Ton $25	2,500 $62,500
	Subtotal		$9,371,112
	Contingencies (25% ±)		2,342,888
	Subtotal		$11,714,000
	Engineering & Design (12% ±)		1,406,000
	Supervision & Administration (10%±)		1,171,000
	TOTAL		$14,291,000
	TOTAL ROUNDED		$14,300,000

*Includes earthen cofferdam

TABLE C-2-5

SUMMARY OF PERTINENT DATA AND FIRST COSTS FOR DIVERSION STRUCTURE

Oakville Site, Mile 70.4

Cost Acct. No.	Item	Unit / Unit Price	Maximum Design Flow (CFS) 5,325	3,550
15.	Diversion Structure			
	Mobilization & Demobilization	Lump Sum	$100,000	$100,000
	Clearing & Grubbing	Lump Sum	$75,000	$75,000
	Relief Wells	Each	4	2
	(Dewatering System)	$35,000	$140,000	$70,000
	Excavation			
	Excavation (Levee and Structure)	Cubic Yard	21,370	15,565
		$2.00	$42,700	$31,100
	Backfill (Levee and Structure)	Cubic ' ard	86,715	80,820
		$5.00	$433,600	$404,100
	Foundation Preparation			
	Stabilization Slab	Cubic Yard	190	110
		$175	$33,200	$19,300
	Fertilizing & Seeding	Acres	0.40	0.20
		$500	$200	$100
	Environmental Protection	Lump Sum	$39,300	$32,600
	Structure			
	Mass Concrete For Structure	Cubic Yard	4,591	2,584
		$325	$1,492,100	$839,800
	Gates & Associated Items			
	Vertical Lift Gates	Each	4	2
		$125,000	$500,000	$250,000
	Walkway for Operating Gates	Each	4	2
		$3,000	$12,000	$6,000
		Linear Feet	8,250	4,125
	Concrete Piles	$25	$206,300	$103,100
	Reinforcing Steel	Pound	459,100	259,700
		$0.60	$275,500	$155,800
	Timber Stoplog Dam	Each	4	4
		$100,000	$400,000	$400,000
	Erosion Protection Riprap		980	690
		$25	$ 24,500	$17,200
	Subtotal		$3,774,400	$2,504,100
	Contingencies (+25%)		$943,600	$626,000
	Subtotal		$4,718,000	$3,130,100
	E&D (+12%)		566,000	375,900
	S&A (+10%)		472,000	313,000
	TOTAL		$5,756,000	$3,819,000
	TOTAL ROUNDED		$5,760,000	$3,820,000

TABLE C-2-6

SUMMARY OF PERTINENT DATA AND FIRST COSTS FOR DIVERSION STRUCTURE

Myrtle Grove Site, Mile 58.7

Cost Acct. No.	Item	Unit / Unit Price	Maximum Design Flow (CFS) 5,325	3,550
15.	Diversion Structure			
	Mobilization and Demobilization	Lump Sum	$100,000	$100,000
	Clearing and Grubbing	Lump Sum	75,000	75,000
	Excavation			
	Excavation (Levee and	Cubic Yard	16,885	11,080
	Structure)	$2.00	$33,800	$22,200
	Backfill (Levee and			
	Structure)	Cubic Yard	86,715	30,820
		$5.00	$443,600	$404,100
	Relief Wells	Each	3	2
	(Dewatering System)	$35,000	$70,000	$105,000
	Foundation, Preparation			
	Stabilization Slab	Cubic Yard	190	110
		$350	$66,500	$38,500
	Fertilizing & Seeding	Acres	0.4	0.4
		$500	200	200
	Environmental Protection	Lump Sum	$39,300	$32,600
	Structure			
	Mass Concrete For	Cubic Yard	4,950	2,760
	Structure	$450	$2,227,500	$1,242,000
	Gates and Associated Items			
	Vertical Lift Gates	Each	4	2
		$125,000	$500,000	$250,000
	Walkway for Operating	Each	4	2
	Gates	$3,000	$12,000	$6,000
	Reinforcing Steel	Pound	495,000	276,000
		$0.60	$297,000	$165,600
	Timber Stoplog Dam	Each	4	4
		$100,000	$400,000	$400,000
	Concrete Piles	Linear Feet	8,250	4,125
		$25	$206,300	$103,100
	Erosion Protection Riprap	Ton	980	690
		$25	$24,500	$17,250
	Subtotal		$4,485,200	$2,961,550
	Contingencies (+25%)		1,114,800	738,450
	Subtotal		$5,600,000	$3,700,000
	E&D (+12%)		670,000	440,000
	S&A (+10%)		560,000	370,000
	TOTAL		$6,830,000	$4,510,000
	TOTAL ROUNDED		$6,830,000	$4,510,000

TABLE C-2-7

SUMMARY OF PERTINENT DATA AND FIRST COSTS FOR DIVERSION STRUCTURE

Big Mar Site, Mile 81.5 (East Bank)

Cost Acct. No.	Item	Unit / Unit Price	Maximum Design Flow (CFS) 6,600	4,400	2,200
15.	Diversion Structure				
	Mobilization and Demobilization	Lump Sum	$100,000	$100,000	$100,000
	Clearing and Grubbing	Lump Sum	75,000	75,000	75,000
	Excavation				
	Excavation (Levee, Structure, and Dam)*	Cubic Yard	70,600	50,450	31,300
		$2.00	$141,200	$100,900	$62,600
	Backfill (Levee, Structure,	Cubic Yard	9,700	7,300	8,700
	and Dam)*	$5.00	$48,500	$36,500	$43,500
	Backfill (Reusable)	Cubic Yard	16,100	12,650	7,900
		$3.00	$48,300	$38,000	$23,700
	Relief Wells (Dewatering	Each	9	6	3
	System)	$35,000	$315,000	$210,000	$105,000
	Foundation Preparation				
	Stabilization Slab	Cubic Yard	1,560	1,050	490
		$175	$273,000	$183,800	$85,800
	Fertilizing and Seeding	Acres	1.0	0.6	0.5
		$500	$500	$ 300	$ 200
	Environmental Protection				
	Structure	Lump Sum	$39,600	$28,400	$16,900
	Mass Concrete For				
	Structure	Cubic Yard	14,150	9,620	5,000
		$325	$4,598,800	$3,126,500	$1,625,000
	Gates and Associated Items				
	Vertical Lift Gates	Each	9	6	3
		$70,000	$630,000	$420,000	$210,000
	Walkway for Operating				
	Gate	Each	9	6	3
		$3,000	$27,000	$18,000	$ 9,000
	Reinforcing Steel	Pound	1,415,000	962,000	500,000
		0.60	$849,000	$577,200	$300,000
		Each	5	5	5
	Timber Stoplogs Dam	$100,000	500,000	500,000	500,000
	Erosion Protection Riprap	Ton	525	370	240
		$25	$13,100	$9,200	$ 6,000
	Subtotal		$7,659,000	$5,423,800	$3,162,700
	Contingencies (+25%)		1,760,000	1,253,200	738,300
	Subtotal		9,419,000	6,667,000	3,901,000
	E&D (+12%)		2,088,000**	813,900	474,000
	S&A (+10%)		957,000	678,100	396,000
	TOTAL FIRST COST		$12,464,000	$8,169,000	$4,771,000
	TOTAL ROUNDED		$12,500,000	$8,170,000	$4,770,000

*Includes earthen cofferdam

**Increased to include initial preconstruction planning estimate for Caernarvon dated 1 February 1982.

drainage canal. The drainage discharged to the swamp follows a course through the swamp toward the southeast, which will be leveed and become the overflow area for the diversion, and enters the various drainage canals that discharge through the pumping station on Cousin Canal. St. Charles Parish officials maintain that part of the pumped discharge from the leveed developments south of Highway 90 also is evacuated through the swamps that will become the overflow area for the diversion. Restoring drainage to pre-project condition is an extremely sensitive matter with local officials and the residents of the area. Several possibilities exist for maintaining drainage with the project in place. The most economical plan developed includes clearing and snagging the canals bordering U.S. Highway 90, a new drainage canal east of Willowdale Boulevard to collect drainage from the swamp area west of the boulevard, and a 360-cfs pumping station to divert the flow over the guide levee into the diversion channel. Local interests reject this plan and strongly contend that the plan would only partially restore pre-project conditions. The plan considered necessary by local interests to maintain pre-project conditions would be a smaller pump at the interection of U.S. Highway 90 and the diversion channel, and an increase in the pumping capacity of the existing Cousin Canal pumping station. This plan would require a 260-cfs pump at the diversion channel and U.S. Highway 90, and a 100-cfs pump addition at the Cousin Canal pumping station. In view of the lack of detailed surveys and information on the drainage system at this time, the plan most acceptable to local interests was included for project cost estimating until such time as additional information is obtained in further studies.

C.2.16. Associated works of the diversion structures include inflow and outflow channels that convey water from the Mississippi River to the structure and then from the structure to a designated water body or area for dispersion into the marshes. The alinements of the inflow channels

are from the Mississippi River to the diversion structures. The inflow channels at the Mississippi River would be lined with riprap to provide erosion protection. Provisions would be made at the Bayou Lasseigne, Davis Pond, and Big Mar sites to tie the channel into existing revetments along the river. Details of the channel tie-in would be provided during advanced engineering and design. The alinements of the outflow channels are shown on plates C-19 through C-24 and described below. Pertinent design features on the channels are shown on table C-2-1.

Diversion Sites	Outflow Channel Alinement	Length (Ft.)
Bayou Lasseigne	A land cut from control structure to Lac Des Allemands	32,080
Bayou Fortier	A land cut westerly for 2500 feet from control structure and then southwesterly to Bayou Fortier then follows Bayou Fortier to Lac Des Allemands.	30,220
Davis Pond	A land cut southerly for about 7,700 feet and then southeasterly for 3,550 feet. The channel flares into the marshes just north of the Salvador Wildlife Mangement Area.	11,250
Oakville	Channel alined south and parallel to Hero Canal for approximately 6,000 feet, then alined southwesterly to intersection with Bayou Concession and Barataria Waterway. Channel then follows Barataria Waterway to Bayou Villars.	44,720
Big Mar	Outflow channel is just west and parallel to Caernarvon canal. Channel flows into Big Mar Lake.	8,100
Myrtle Grove	A land cut southwesterly for 2,900 feet to Wilkinson Canal. Channel follows existing Wilkinson Canal for about 26,000 feet to Oak Bayou. Laterals are provided in canal to deliver water directly to Lake Laurier via Bayou McCutchen and deliver water to Bayou Dupont.	43,600

RELOCATIONS

C.2.21. Determining the relocations required as a result of constructing the six diversion structures and associated works was based on available office information. No field studies were conducted. Thirty-six relocations would be required for the six sites. Distribution of relocations between relocation categories is shown below:

Diversion Site	Telephone Lines	Number of Relocations		
		Pipeline	Highways & Roads	Railroads
Bayou Lasseigne	-	2	2	1
Bayou Fortier	-	2	3	1
Davis Pond	3	7	2	2
Oakville		1	1	1
Big Mar	-	3	1	1
Myrtle Grove	-	1	1	1
TOTAL	3	16	10	7

C.2.22. All pipelines would be built to the capacities and equivalent engineering criteria of the existing facilities. Highway and roads would be replaced to current Louisiana highway standards. Relocated railroads would be built to the same load limitation and engineering criteria as the existing facility. Pertinent information on the proposed relocations at the five diversion sites is displayed in tables C-2-18 to C-2-23.

SUMMARY OF PERTINENT DATA AND FIRST COSTS OF LEVEE SETBACK

Oakville (Mile 70.4) and Myrtle Grove (Mile 58.7) Sites

Cost Acct. No.	Item	Unit / Unit Price	Maximum Design Flow (CFS) [illegible],325	Maximum Design Flow (CFS) 3,560
11.	Levee			
	Clearing and Grubbing	Acres	6	6
		$1,000	$6,000	$6,000
	Embankment	Cubic Yard	62,000	62,000
		$2.50	$155,000	$155,000
	Concrete Slope Paving	Square Yard	760	760
		$200	$152,000	$152,000
	Fertilizing & Seeding	Acres	6	6
		$500	3,000	3,000
	Shells	Cubic Yard	600	600
		$18	$10,800	$10,800
	Subtotal		$326,800	$326,800
	Contingencies (+25%)		81,200	81,200
	Subtotal		$408,000	$408,000
	E&D (7% ±)		28,600	28,600
	S&A (9% ±)		36,400	36,400
TOTAL			$473,000	$473,000
TOTAL ROUNDED			$473,000	$473,000

TABLE C-2-16

SUMMARY OF PERTINENT DATA AND FIRST COSTS OF DIKE

Big Mar Site, Mile 81.5

Cost Acct. No.	Item	Unit / Unit Price	Maximum Design Flow (CFS) 6,600	4,400	2,200
11.	Levees				
	Clearing	Acres	2.9	2.9	2.9
		$1,000	$2,900	$2,900	$2,900
	Embankment	Cubic Yards	20,000	20,000	20,000
		$2.50	$50,000	$50,000	$50,000
	Subtotal		$52,900	$52,900	$52,900
	Contingencies (+25%)		13,200	13,200	13,200
	Subtotal		$66,100	$66,100	$66,100
	E&D (+7%)		6,600*	4,600	4,600
	S&A (+9%)		6,000	6,000	6,000
	TOTAL		$78,700	$76,700	$76,700
	TOTAL ROUNDED		$79,000	$77,000	$77,000

*Increase to include a portion of the preconstruction planning estimate for Caernarvon dated 1 July 1982.

and would extend from Forty Arpent Canal to Delacroix Canal. The dike would be constructed with a floating dragline. Dike elevations would vary from +3 to +5 NGVD with a 5-foot crown and 1V on 3H slope. The dike would be approximately 2 miles long. The first cost of the dike is shown in table C-2-16.

C.2.20. As previously indicated, the limited space between the levee and river at the Oakville and Myrtle Grove sites prevents placing the culvert structure in the existing levee. The structures would be placed in levee setbacks and pile foundations may be required. The levee setbacks would provide the same level of protection as existing levees. A summary of first costs for the levee setbacks are shown in table C-2-17.

TABLE C-2-15

SUMMARY OF PERTINENT DATA AND FIRST COSTS OF LEVEES

Davis Pond Site, Mile 118.4

Cost Acct. No.	Item	Unit / Unit Price	Maximum Design Flow (CFS) 10,650
11.	Levees		
	Clearing	Acres $1,000	109 $109,000
	Embankment (Semi-compacted)	Cubic Yard $3.00	500,000 $1,500,000
	West Guide Levee	Cubic Yard $2.50	95,000 $237,500
	Shell	Cubic Yard $18.00	8,500 $153,000
	Fertilizing and Seeding	Acres $500.00	28 $14,000
	Subtotal		$2,013,500
	Contingencies (25% ±)		506,500
	Subtotal		$2,520,000
	E&D (7% ±)		176,000
	S&A (9% ±)		224,000
	TOTAL		$2,920,000
	TOTAL ROUNDED		$2,920,000

TABLE C-2-14

EXCAVATED MATERIAL QUANTITIES

Diversion Site	Maximum Design Flow (CFS)	Excavated material (Cu. Yd)
Bayou Lasseigne	10,650	5,143,700
	7,100	4,091,300
	5,325	3,164,800
	3,550	2,098,700
Bayou Fortier	10,650	6,110,000
	7,100	3,970,000
	5,325	3,290,000
	3,550	1,850,000
Davis Pond	10,650	2,080,000
Oakville	5,325	1,176,000
	3,550	616,000
Big Mar	6,600	320,000
	4,400	216,000
	2,200	111,000
Myrtle Grove	5,325	1,377,000
	3,550	1,244,000

smaller. Some incidental excavation may be required for placement of timber stoplog weirs. Excavated material would be placed adjacent to the weir locations. Details of the weirs are shown on plate C-31. Typical cross sections showing the channels, levees, and disposal of excess excavated material are shown on plates C-32 to C-41. The typical cross sections shown on the plates are for the largest maximum design flow considered at each site. The amount of material to be excavated is shown in table C-2-14.

C.2.18. At the Davis Pond site, the excess excavated material obtained from the inflow and outflow channels to US Highway 90 would be about 550,000 cubic yards and would be used to construct 1.7 miles of channel guide levees along the outflow channel, 2.3 miles of west guide levees from the impoundment, and 0.6 miles of guide levee for the outflow channel along its left descending bank south of US Highway 90. In addition, the excess excavated material would be used to construct 0.7 miles of east guide levee from the outflow channel levee to the borrow channel adjacent to US Highway 90 and 1.2 miles of guide levees for the outflow channel along its right descending bank from US Highway 90 to where the channel flares into the marshes. Material excavated from the channel south of US Highway 90 (835,000 cubic yards) would be used to create 175 acres of marshes. A major portion of the east guide levee (about 5 miles) would be constructed from material obtained from clearing and snagging Bayou Verret and the existing access canal. The lower 2.9 miles of the west guide would be constructed from material borrowed from the area adjacent to the levee alignment. A summary of pertinent data and first cost for the [illegible] at the Davis Pond site is shown in table C-2-15.

C.2.19. At the Big Mar site, a dam to prevent the diverted water from entering the privately owned Caernarvon Canal will be constucted (see plate C-24). This dam would be located on the north bank of Forty Arpent Canal between the proposed outflow channel and Caernarvon Canal

TABLE C-2-13

SUMMARY OF PERTINENT DATA AND FIRST COSTS FOR CHANNEL

Big Mar Site, Mile 81.5 (East Bank)

Cost Acct No.	Item	Unit / Unit Price	Maximum Design Flow (CFS) 6,600	4,400	2,200
09.	Channel	Acres	93	72	58
	Mobilization and Demobilization	Lump Sum $75,000	$75,000	$75,000	$75,000
	Clearing	$1,000	$93,000	$72,000	$58,000
	Excavation	Cubic Yards	320,000	216,000	111,000
		$1.00	$320,000	$216,000	$111,000
	Subtotal		$488,000	$363,000	$244,000
	Contingencies (+25%)		122,000	91,000	61,000
	Subtotal		$610,000	$454,000	$305,000
	E&D (+7%)		45,000*	32,000	21,000
	S&A (+9%)		55,000	41,000	27,000
	TOTAL		$710,000	$527,000	$353,000
	TOTAL ROUNDED		$710,000	$527,000	$353,000

*Increase to include a portion of the preconstruction planning estimate for Caernarvon dated 1 July 1982.

TABLE C-2-12

SUMMARY OF PERTINENT DATA AND FIRST COSTS FOR CHANNEL

Myrtle Grove Site, Mile 58.7

Cost Acct. No.	Item	Unit / Unit Price	Maximum Design Flow (CFS) 5,325	3,550
09.	Channel			
	Mobilization and Demobilization	Lump Sum	$75,000	$75,000
	Clearing	Acres	333	321
		$1,000	$333,000	$321,000
	Excavation	Cubic Yards	1,377,000	1,224,000
		$1.00	1,377,000	1,224,000
	Subtotal		$1,785,000	$1,620,000
	Contingencies (+25%)		445,000	400,000
	Subtotal		$2,230,000	$2,020,000
	E&D (+7%)		160,000	140,000
	S&A (+9%)		200,000	180,000
	TOTAL		$2,590,000	$2,340,000
	TOTAL ROUNDED		$2,590,000	$2,340,000

TABLE C-2-11

SUMMARY OF PERTINENT DATA AND FIRST COST FOR CHANNEL

Oakville Site, Mile 70.4

Cost Acct. No.	Item	Unit / Unit Price	Maximum Design Flow (CFS) 5,325	3,550
09.	Channel			
	Mobilization and	Lump Sum		
	Demobilization	$75,000	$75,000	$75,000
	Clearing	Acres	422	362
		$1,000	$422,000	$362,000
	Excavation	Cubic Yards	1,176,000	616,000
		0.85	$999,600	$554,400
	Subtotal		$1,[illegible]96,600	$991,400
	Contingencies (+25%)		373,400	248,600
	Subtotal		$1,870,000	$1,240,000
	E&D (+7%)		130,000	88,000
	S&A (+4%)		[illegible]	112,000
	TOTAL		$2,170,000	$1,440,000
	TOTAL ROUNDED		$2,170,000	$1,440,000

TABLE C-2-10

SUMMARY OF PERTINENT DATA AND FIRST COST
FOR CHANNEL AND LEVEES

DAVIS POND SITE, MILE 118.4

Cost Acct. No.	Item	Unit / Unit Price	Maximum Design Flow (CFS) 10,650
09.	Channels		
	Mobilization and Demobilization	Lump Sum $75,000	 $75,000
	Clearing	Acres $1,000	91 $91,000
	Excavation and bucket dragline to be used in levee embankment	Cubic Yard $1.00	650,000 $650,000
	Excavation by hydraulic dredge to be used for marsh creation	Cubic Yard $0.85	835,000 $709,750
	Ditch Cleanout	Linear Feet $5.00	10,200 $51,000
	Access Channel-Cleanout of Bayou Verret and Borrow Canal	Linear Feet $15.00	32,000 $480,000
	Subtotal		$2,056,750
	Contingencies (25% ±)		513,250
	Subtotal		$2,570,000
	Engineering & Design(7% ±)		180,000
	Supervision & Administration (9% ±)		231,000
	TOTAL		$2,981,000
	TOTAL ROUNDED		$2,980,000

TABLE C-2-9

SUMMARY OF PERTINENT DATA AND FIRST COSTS FOR CHANNEL

Bayou Fortier Site, Mile 132.0

Cost Acct. No.	Item	Unit / Unit Price	Maximum Design Flow (CFS) 10,650	7,100	5,325	3,550
09.	Channel					
	Mobilization and Demobilization	Lump Sum $75,000	$75,000	$75,000	$75,000	$75,000
	Clearing	Acres	776	617	556	439
		$1,000	$776,000	$617,000	$556,000	$439,000
	Excavation	Cubic Yard	6,110,000	3,970,000	3,290,000	1,850,000
		0.90	$5,499,000	$3,573,000	$2,796,500	$1,572,500
	Subtotal		$6,350,000	$4,265,000	$3,427,500	$2,086,500
	Contingencies (+25%)		1,590,000	1,065,000	852,500	523,500
	Subtotal		$7,940,000	$5,330,000	$4,280,000	$2,610,000
	E&D (+6%)		555,000	370,000	300,000	185,000
	S&A (+9%)		715,000	480,000	380,000	235,000
	TOTAL		$9,210,000	$6,180,000	$4,960,000	$3,030,000
	TOTAL ROUNDED		$9,210,000	$6,180,000	$4,960,000	$3,030,000

TABLE C-2-8

SUMMARY OF PERTINENT DATA AND FIRST COSTS FOR CHANNEL

Bayou Lasseigne Site, Mile 141.1

Cost Acct. No.	Item	Unit / Unit Price	Maximum Design Flow (CFS) 10,650	7.100	5.325	3,550
09.	Channel					
	Mobilization &	Lump Sum				
	Demobilization	$75,000	$75,000	$75,000	$75,000	$75,000
	Clearing	Acres	648	560	481	389
		$1,000	$648,000	$560,000	$481,000	$389,000
	Excavation	Cubic Yards	5,143,700	4,091,300	3,164,800	2,098,700
		0.90	$4,629,300	$3,682,200	$2,690,000	$1,783,900
	Subtotal		$5,352,300	$4,317,200	$3,246,000	$2,247,900
	Contingencies (+25%)		1,337,700	1,082,800	814,000	562,100
	Subtotal		6,690,000	5,400,000	4,060,000	2,810,000
	E&D (± 7%)		470,000	380,000	280,000	197,000
	S&A (± 9%)		600,000	490,000	360,000	253,000
	TOTAL		$7,760,000	$6,270,000	$4,700,000	$3,260,000
	TOTAL ROUNDED		$7,760,000	$6,270,000	$4,700,000	$3,260,000

C.2.17. The inflow and outflow channels would be excavated by bucket dredges at all sites except Davis Pond. At the Davis Pond site, bucket dredges would be used to excavate the channel from the control structure to the access canal adjacent to US Highway 90. Below the access canal, the remaining channel would be excavated by a hydraulic dredge. Excavation of channels to design cross sections would take an estimated 3 to 19 months per channel, depending on the length and size of the channels. This estimate is based on using two draglines per channel excavating 10,000 cubic yards per day. Mobilization, demobilization, and clearing would take an estimated 60 days. Pertinent data and first costs for channels are shown in tables C-2-8 to C-2-13. The outflow channels are designed to convey the flow within banks most of the time. However, guide levees would be provided along most of the length of the channels as an added safety factor for periods of maximum flow discharge, high tides, and southerly winds. The guide levees would also prevent the excess excavated material from falling back into the channel. The excavated materials would be used to construct the levees parallel to the channel. Distances to the toe of the levees from the top of the channel cut vary from 25 to 50 feet. The levees would be 2 to 5 feet high with 1V to 3H slopes and 5- to 10-foot crowns. Excess excavated material at all sites except the Davis Pond site would be disposed of in the same location as identified for the guide levees and would enlarge the levee dimensions significantly to 6 to 15 feet high with 1V on 4H slopes on the natural levee deposits and 1V on 6H slopes in the marshes. Crowns of the excavated material sections would range from 8 to 192 feet. At the Myrtle Grove site, excavated material from the inflow channel would be placed in existing borrow pits. From the diversion structure to Wilkinson Canal, excavated material would be placed parallel to the excavated canal. The existing Wilkinson Canal is nearly the size intended for the outflow channel and considerably less dredging is necessary. Consequently, new disposal area would be

TABLE C-2-18

SUMMARY OF PERTINENT DATA AND FIRST COSTS FOR RELOCATIONS

Bayou Lasseigne Site, Mile 141.1

Cost Acct. No.	Item	Unit / Unit Price	Maximum Design Flow (CFS) 10,650	7,100	5,325	3,550
02	Relocations					
02.1	Roads and Bridges 1/					
	LA Hwy (2-Lane)					
	Remove Existing Road					
	Pavement	Linear Feet	140	100	80	60
		$24 x 1.06	$3,562	$2,544	$2,035	$1,526
		Cubic Yard	34,560	20,040	15,730	11,430
	Embankment	$2 x 1.06	$73,267	$42,485	$33,348	$24,232
	Reinstall Existing Road					
	Pavement	Linear Feet	140	100	80	60
		$150 x 1.06	$22,260	$15,900	$12,720	$9,540
	Embankment	Cubic Yard	34,560	20,040	15,730	11,430
		$5 x 1.06	$183,168	$106,212	$83,369	$60,579
	Install Temporary By-Pass Road					
	Pavement	Linear Feet	700	660	640	620
		$150 x 1.06	$111,300	$104,940	$101,760	$98,580
	Embankment	Cubic Yard	6,000	5,650	5,480	5,301
		$5 x 1.06	$31,800	$29,945	$29,044	$28,095
	Remove Temporary By-Pass Road					
	Pavement	Linear Feet	700	660	640	620
		$24 x 1.06	$17,808	$16,790	$16,282	$15,773
	Embankment	Cubic Yard	6,000	5,650	5,480	5,301
		$2 x 1.06	$12,720	$11,978	$11,618	$11,238
	Local Road (2-Lane)					
	Owner unknown					
	Construct Bridge	Linear Feet	200	200	200	200
		$1500 x 1.06	$318,000	$318,000	$318,000	$318,000
02.4	Railroads and Bridges 2/					
	Texas and Pacific Railroad					
	Remove Existing Tracks	Linear Feet	140	100	80	60
		$10 x 1.06	$1,484	$1,060	$848	$636
	Track Embankment	Cubic Yard	30,130	25,850	20,720	15,600
		$2 x 1.06	$63,876	$54,802	$43,926	$33,072
	Reinstall Existing Tracks	Linear Feet	140	100	80	60
		$50 x 1.06	$7,420	$5,300	$4,240	$3,180
	Backfill Embankment	Cubic Yard	30,130	25,850	20,720	15,600
		$3 x 1.06	$95,813	$82,203	$65,890	$49,608
	Install Temporary By-Pass Track	Linear Feet	700	660	640	620
		$150 x 1.06	$111,300	$104,940	$101,760	$98,580
	Backfill Embankment	Cubic Yard	158,670	149,600	145,070	140,540
		$5 x 1.06	$840,951	$792,880	$768,871	$744,862
	Removal Temporary Track	Linear Feet	700	660	640	620
		$10 x 1.06	$7,420	$6,996	$6,784	$6,572
	Embankment	Cubic Yard	158,670	149,600	145,070	140,540
		$2 x 1.06	$336,380	$317,152	$307,548	$297,945
02.7	Pipelines 3/					
	Sugar Bowl Gas Corp					
	20" Natural Gas Pipeline	Linear Feet	920	775	680	520
		$345 x 1.06	$336,444	$283,418	$248,676	$190,164
	Transcontinental Gas Pipeline Corp					
	10" Natural Gas Pipeline	Linear Feet	920	775	680	520
		$175 x 1.06	$170,660	$143,763	$126,140	$96,460
	Subtotal		$2,745,633	$2,441,308	$2,282,859	$2,088,642
	Contingencies (+25%)		686,408	610,327	570,715	522,161
	Subtotal		$3,432,041	$3,051,635	$2,853,574	$2,610,803
	Engineering and Design (+6%)		205,923	183,098	171,214	156,648
	Supervision and Administration (+6%)		205,923	183,098	171,214	156,648
	TOTAL FIRST COST		$3,843,887	$3,417,831	$3,196,002	$2,924,099
	TOTAL ROUNDED		$3,844,000	$3,418,000	$3,196,000	$2,924,000

1/ Relocated highways will be replaced to current design standards.

2/ Relocated railroads will be built to the same load limitations as engineering criteria as possessed by the existing railroad facility.

3/ Relocated pipelines will be built to the capacities and equivalent engineering criteria as possessed by the existing facilities.

TABLE C-2-19

SUMMARY OF PERTINENT DATA AND FIRST COSTS FOR RELOCATIONS

Bayou Portier Site, Mile 132.0

Cost Acct. No.	Item	Unit / Unit Price	Maximum Design Flow (CFS) 10,650	7,100	5,325	3,550
02.	Relocations					
02.1	Roads & Bridges [1]					
	La. State Hwy 3127 (4-Lane)					
	Remove Existing Road Pavement	Linear Feet	700	625	545	250
		$24 x 1.06	$17,808	$15,900	$13,865	$6,360
	Replace Existing Road Pavement	Linear Feet	700	625	545	250
		$150 x 1.06	$111,300	$99,375	$86,655	$39,750
	Steel Deck Bridge	Linear Feet	700	625	545	250
		$1500 x 1.06	$1,113,000	$993,750	$866,550	$397,500
	La. State Hwy 18 (2-Lane)					
	Remove Existing Road Pavement	Linear Feet	140	100	80	60
		$24 x 1.06	$3,562	$2,544	$2,035	$1,526
	Embankment	Cubic Yard	34,568	20,040	15,730	11,430
		$2 x 1.06	$73,267	$42,485	$33,348	$24,232
	Reinstall Road Pavement	Linear Feet	140	100	80	60
		$150 x 1.06	$22,260	$15,900	$12,720	$9,540
	Backfill Embankment	Cubic Yard	34,560	20,040	15,730	11,430
		$5 x 1.06	$183,168	$106,212	$83,369	$60,579
	Install Temporary By-Pass Road Pavement	Linear Feet	700	660	640	620
		$150 x 1.06	$111,300	$104,940	$101,760	$98,580
	Embankment	Cubic Yard	6,000	5,650	5,480	5,301
		$5 x 1.06	$31,800	$29,945	$29,044	$28,095
	Remove Temporary By-Pass Road Pavement	Linear Feet	700	660	640	620
		$24 x 1.06	$17,808	$16,790	$16,282	$15,773
	Embankment	Cubic Yard	6,000	5,650	5,480	5,301
		$2 x 1.06	$12,720	$11,978	$11,618	$11,238
	Local Road (2-Lane) (Owner Unknown)					
	New Bridge	Linear Feet	270	230	210	190
		$1500 x 1.06	$429,300	$365,700	$333,900	$302,100
02.4	Railroads & Bridges [2]					
	Texas and Pacific Railroad					
	Remove Existing Track	Linear Feet	140	100	80	60
		$10 x 1.06	$1,484	$1,060	$848	$636
	Track Embankment	Cubic Yard	30,130	25,850	20,720	15,600
		$2 x 1.06	$63,876	$54,802	$43,926	$33,072
	Reinstall Existing Track	Linear Feet	140	100	80	60
		$50 x 1.06	$7,420	$5,300	$4,240	$3,180
	Backfill Embankment	Cubic Yard	30,130	25,850	20,720	15,600
		$3 x 1.06	$95,813	$82,203	$65,890	$49,608
	Install Temporary By-Pass Track	Linear Feet	700	660	640	620
		$150 x 1.06	$111,300	$104,940	$101,760	$98,580
	Backfill Embankment	Cubic Yard	158,700	149,600	145,070	140,540
		$5 x 1.06	$841,110	$792,880	$768,871	$744,862
	Remove Temporary By-Pass Track	Linear Feet	700	660	640	620
		$10 x 1.06	$7,420	$6,996	$6,784	$6,572
	Embankment	Cubic Yard	158,700	149,600	145,070	140,540
		$2 x 1.06	$336,444	$317,152	$307,548	$297,945
02.7	Pipelines [3]					
	Sugar Bowl Gas Corp					
	20" Natural Gas Pipeline	Linear Feet	1,045	825	755	585
		$345 x 1.06	$382,157	$301,703	$276,104	$213,935
	Transcontinental Gas Pipeline Co.					
	8" Natural Gas Pipeline	Linear Feet	1,045	825	755	585
		$140 x 1.06	$155,078	$122,430	$112,042	$86,814
	Subtotal		$4,129,395	$3,594,985	$3,279,159	$2,530,477
	Contingencies (+25%)		1,032,349	898,746	819,790	632,619
	Subtotal		$5,161,744	$4,493,731	$4,098,949	$3,163,096
	E&D (+6%)		309,705	269,624	245,937	189,786
	S&A (+6%)		309,705	269,624	245,937	189,786
	TOTAL		$5,781,154	$5,032,979	$4,590,823	$3,542,668
	TOTAL ROUNDED		$5,781,000	$5,033,000	$4,591,000	$3,543,000

1/ Relocated highway will be replaced to Louisiana current highway standards.

2/ Relocated Railroads will be built to the same load limitations and engineering criteria as the existing railroad facility.

3/ Relocated Pipelines will be built to the capacities and equivalent engineering criteria as possessed by the existing facilities.

TABLE C-2-20

SUMMARY OF PERTINENT DATA AND FIRST COSTS FOR RELOCATIONS

DAVIS POND SITE, MILE 118.4

Cost Acct. No.	Item	Unit / Unit Price	Maximum Design Flow (CFS) 10,650
02.0	Relocations		
02.1	Roads and Bridges		
	a. LA. Hwy 18	Linear Feet	500
	Remove Existing Road	$27	$13,780
	Install Temp By-Pass Road	Linear Feet	600
		$169	$101,760
	Install Temp Road	Linear Feet	2,670
	Pavement	$5.61	$15,000
	Remove Temp Road	Linear Feet	600
		$27	$16,536
	Remove Road Embankment	Cubic Yard	2,670
		$2.12	$ 5,660
	New Roadway Pavement	Linear Feet	550
		$169	$93,280
	Road Embankment	Cubic Yard	5,100
		$5.61	$28,652
	b. US Hwy. 90		
	Remove Existing Road	Linear Feet	1,000
		$27	$27,560
	New Road Pavement	Linear Feet	1,100
		$169	$186,560
	Road Embankment	Cubic Yard	10,200
		$5.61	$57,304
	Install Temp By-Pass	Linear Feet	600
		$169	$101,760
	Install Road Embankment	Cubic Yard	2,650
		$5.60	$15,000
	Remove Temp Road	Linear Feet	600
		$27	$16,536
	Remove Road Embankment	Cubic Yard	2,670
		$2.12	$ 5,660
	Steel Deck Bridge	Linear Feet	400
		$2,544	$1,017,600
02.4	Railroad and Bridges		
	Texas & Pacific R/R		
	Southern Pacific R/R		
	Remove Existing Track	Linear Feet	2,000
		$11.66	$23,320
	Reinstall Track	Linear Feet	$2,000
		$56	$112,360
	Install Temp By-Pass Tracks	Linear Feet	3,000
		$169	$508,800
	Remove Temp Tracks	Linear Feet	3,000
		$11.66	$34,980
	Southern Pacific R/R		
	Steel Deck Bridge	Linear Feet	400
		$1,378	$551,200
	Texas & Pacific R/R		
	Steel Deck Bridge	Linear Feet	400
		$2,438	$975,200
	Texas & Pacific R/R		
	Communication Lines	Linear Feet	550
		$15.90	$ 8,745
02.7	Utilities		
	Pipelines		
	8" LGS gas pipeline	Linear Feet	550
		$148	$81,620
	8" Oil pipelines	Linear Feet	670
		$148	$99,428
	Shell Oil Co.	Linear Feet	670
	10" Oil Pipelines	$169	$113,632
	Shell Oil Co.		
	20" oil pipelines	Linear Feet	670
		$381	$255,672
	United Gas Co.	Linear Feet	670
	20" natural gas pipelines	$381	$255,672
	Texaco, Inc.	Linear Feet	150
	22" gas pipeline	$403	$60,420
	St. Charles Parish	Linear Feet	550
	12" D.I. Waterline @US Hwy 90	$212	$116,600
	8" D.I. Waterline @ LA Hwy 18	$135	$74,250
	Powerlines		
	13.8 KV Aerial Powerline	Linear Feet	550
	(LP&L)	$21	$11,660
	115KV Aerial Powerline	Lump Sum	$21,200
	Telephone		
	Two 220 Pair Telephone	Linear Feet	1,100
	Cable (S.C.B)	$26	$29,150
	Subtotal		$5,036,557
	Contingencies(25 ±)		1,258,443
	Subtotal		$6,295,000
	Engineering & Design (6+)		$378,000
	Supervision & Administration (6+)		378,000
	TOTAL		$7,051,000
	TOTAL ROUNDED		$7,050,000

TABLE C-2-21

SUMMARY OF PERTINENT AND FIRST COSTS FOR RELOCATIONS

Oakville Site, Mile 70.4

Cost Acct. No.	Item	Unit / Unit Price	Maximum Design Flow (CFS) 5,325	3,550
02.	Relocations			
02.1	Roads and Bridges 1/			
	La. Hwy 23			
	Remove Embankment	Cubic Yard	5,690	5,690
		$2 x 1.06	$12,063	$12,063
	Existing Road Remove Pavement	Linear Feet	160	160
		$24 x 1.06	$4,070	$4,070
	Reinstall Pavement	Linear Feet	160	160
		$150 x 1.06	$25,440	$25,440
	Temporary By-Pass for Hwy			
	Install Roadway Pavement	Linear Feet	650	650
		$150 x 1.06	$103,350	$103,350
	Road Embankment	Cubic Yard	2,243	2,243
		$5 x 1.06	$11,888*	$11,888*
	Remove Roadway Pavement	Linear Feet	650	650
		$24 x 1.06	$16,536	$16,536
	Roadway Embankment	Cubic Yard	2,243	2,243
		$2 x 1.06	$4,755*	$4,755*
	Steel Deck Bridge	Linear Feet	80	80
		$2,000 x 1.06	$169,600	$169,600
02.4	Railroads & Bridges 2/			
	Lower Coast RR			
	Remove Existing Track	Linear Feet	160	160
		$10 x 1.06	$1,696	$1,696
	Reinstall Track	Linear Feet	160	160
		$50 x 1.06	$8,480	$8,480
	Temporary By-Pass For RR			
	Install RR Embankment	Cubic Yard	2,243	2,243
		$5 x 1.06	$11,888*	$11,888*
	Remove RR Embankment	Cubic Yard	2,243	2,243
		$2 x 1.06	$4,755*	$4,755*
	Install Track	Linear Feet	650	650
		$150 x 1.06	$103,350	$103,350
	Remove Track	Linear Feet	650	650
		$10 x 1.06	$6,890	$6,890
	Steel Deck Bridge	Linear Feet	80	80
		$2,000 x 1.06	$169,600*	$169,600*
02.7	Pipelines 3/			
	United Gas Pipeline Co.			
	12" Natural Gas Pipeline	Linear Feet	360	260
		$210 x 1.06	$80,136	$57,876
	Subtotal		$ $734,497	$712,237
	Contingencies (+25%)		183,624	178,059
	Subtotal		$918,121	$890,296
	E&D (+6%)		55,087	53,418
	S&A (+6%)		55,087	53,418
	TOTAL		$1,028,295	$997,132
	TOTAL ROUNDED		$1,028,000	$997,000

1/ Relocated Highways will be replaced to Louisiana Hwy standards.

2/ Relocated Railroads will be built to the same load limitations and engineering criteria as possessed by the existing railroad facility.

*50 % of cost to roads and bridges, 50% cost to railroads and bridges.

3/ Relocated Pipelines will be built to the capacities and equivalent criteria as possessed by the existing facility.

TABLE C-2-22

SUMMARY OF PERTINENT DATA AND FIRST COSTS FOR RELOCATIONS

Big Mar Site, Mile 81.5

Cost Acct. No.	Item	Unit / Unit Price	Maximum Design Flow (CFS) 6,600	4,400	2,200
02	Relocations				
02.1	Roads and Bridges				
	LA Hwy 39 (2-Lane)				
	Remove Existing Road	Linear Feet	230	160	100
		$24 x 1.06	$5,851	$4,070	$2,544
	Replace Existing Road	Linear Feet	230	160	100
		$150 x 1.06	$36,570	$25,440	$15,900
	Install Temporary By-Pass				
	Road Pavement	Linear Feet	750	750	650
		$150 x 1.06	$119,250	$119,250	$103,350
	Embankment	Cubic Yard	6,000	6,000	5,200
		$5 x 1.06	$31,800	$31,800	$27,560
	Remove Temporary By-Pass				
	Road Pavement	Linear Feet	750	750	650
		$24 x 1.06	$19,080	$19,080	$16,536
	Embankment	Linear Feet	6,000	6,000	5,200
		$2 x 1.06	$12,720	$12,720	$11,024
02.4	Railroads and Bridges 2/				
	Southern Railway				
	Remove Existing Track	Linear Feet	230	160	100
		$10 x 1.06	$2,438	$1,696	$1,060
	Reinstall Existing Track	Linear Feet	230	160	100
		$50 x 1.06	$12,190	$8,480	$5,300
	Install Temporary By-Pass Track	Linear Feet	750	750	650
		$150 x 1.06	$119,250	$119,250	$103,350
	Remove Temporary By-Pass Track	Linear Feet	750	750	650
		$10 x 1.06	$7,950	$7,950	$6,890
02.7	Pipelines 3/				
	Southern Natural Gas Co.				
	12" Natural Gas Pipeline	Linear Feet	70	70	70
		$210 x 1.06	$15,882	$15,882	$15,882
	16" Natural Gas Pipeline	Linear Feet	70	70	70
		$280 x 1.06	$20,776	$20,776	$20,776
	Shell Oil Co.				
	10" Oil Pipeline	Linear Feet	70	70	70
		$160 x 1.06	$11,872	$11,872	$11,872
	Subtotal		$415,629	$398,266	$342,044
	Contingencies (±25%)		103,907	99,567	85,511
	Subtotal 4/		$519,536	$497,833	$427,555
	E&D (+6%)		31,172	29,870	25,653
	S&A (+6%)		31,172	29,870	25,653
	TOTAL		$581,880	$557,578	$478,861
	TOTAL ROUNDED		$582,000	$558,000	$479,000

1/ Relocated Highways will be replaced to Louisiana Hwy standards.

2/ Relocated railroads will be built to the same load limitations and engineering criteria as possessed by the existing railroad facilities.

3/ Relocated pipelines will be built to the capacities and equivalent engineering criteria as possessed by the existing facilities.

4/ Increased to include initial preconstruction planning estimate for Caernarvon dated 1 February 1982.

TABLE C-2-23

SUMMARY OF PERTINENT DATA AND FIRST COSTS FOR RELOCATION

Myrtle Grove Site, Mile 58.7

Cost Acct. No.	Item	Unit / Unit Price	Maximum Design Flow (CFS) 5,350	3,550
02.	Relocation			
02.1	Roads and Bridges (La. Hwy. 23) 1/			
	Remove Embankment	Linear Feet	5,690	5,690
		$2 x 1.06	$12,063	$12,063
	Existing Road			
	Remove Pavement	Linear Feet	160	160
		$24 x 1.06	$4,070	$4,070
	Reinstall Pavement	Linear Feet	160	160
		$150 x 1.06	$25,440	$25,440
	Temporary By-Pass			
	Install Roadway Pavement	Linear Feet	650	650
		$150 x 1.06	$103,350	$103,350
	Install Roadway Embankment*	Cubic Yard	2,243	2,243
		$5 x 1.06	$11,888*	$11,888*
	Remove Roadway Pavement	Linear Feet	650	650
		$24 x 1.06	$16,536	$16,536
	Remove Roadway Embankment	*Cubic Yard	2,243	2,243
		$2 x 1.06	$4,755*	$4,755*
	Steel Deck Bridge*	Linear Feet	80	80
		$2,000 x 1.06	$169,600	$169,600
02.4	Railroad and Bridges 2/			
	Remove Existing Railroad track	Linear Feet	160	160
		$10 x 1.06	$1,696	$1,696
	Reinstall Existing Railroad track	Linear Feet	160	160
		$50 x 1.06	$8,480	$8,480
	Temporary By-Pass			
	Install Railroad Embankment*	Cubic Yard	2,243	2,243
		$5 x 1.06	$11,888*	$11,888*
	Remove Railroad Embankment*	Cubic Yard	2,243	2,243
		$2 x 1.06	$4,755*	$4,755*
	Temporary Railroad By-Pass			
	Install Track	Linear Feet	650	650
		$150 x 1.06	$103,350	$103,350
	Remove Track	Linear Feet	650	650
		$10 x 1.06	$6,890	$6,890
	Steel Deck Bridge	Linear Feet	80	80
		$2,000 x 1.06	$169,600*	$169,600*
02.7	Pipelines 3/			
	20" Oil Pipeline (Shell Oil Co.)	Linear Feet	360	260
		$315 x 1.06	$120,204	$86,814
	SUBTOTAL		$774,565	$741,175
	Contingencies (+25%)		193,641	185,294
	Subtotal		$968,206	$926,469
	E&D (+6%)		58,092	55,588
	S&A (+6%)		58,092	55,588
	TOTAL		$1,084,390	$1,037,645
	TOTAL ROUNDED		$1,084,000	$1,038,000

*50% allocated to Roads and bridges and 50% allocated to railroads and bridges.

1/ Relocated highways will be replaced to louisiana current hwy standards.

2/ Relocated railroads will be built to the same load limitations and engineering criteria as possessed by the existing railroad facility.

3/ Relocated pipelines will be built to the capacities and equivalent criteria as possessed by the existing facility.

REAL ESTATE

C.2.23. Lands required to construct the diversion sites and associated works include structure and bridge sites, channel and levee rights-of-way, construction and disposal areas, and lands for dispersion of freshwater to the marshes. The different types of lands required by purpose are shown below:

Structure, Bridge, and Pumping Station	Agricultural, Industrial Residential/Commercial	Fee
Channel	Agricultural, Marshland Industrial, Woodland Residential/Commercial	Perpetual Rights-of-way
Levee and dike	Marshland, Levee protected land.	Perpetual Rights-of-way
Excavated Material disposal	Agricultural, Marshland Residential/Commerical Industrial, Woodland	Perpetual Easement
Construction	Agricultural, Industrial Residential/Commercial	Temporary Easement
Dispersion of freshwater to the marshes	Marshland, Woodland	Perpetual Easement

C.2.24. Lands for diversion sites by type of acquisition are shown in table C-2-24. Lands for diversion structures and accompanying bridges would be acquired in fee. Lands for the inflow and outflow channels, levees and dikes, and for excavated material would be acquired on a perpetual easement basis. A temporary easement would be acquired on

TABLE C-2-24

LANDS REQUIRED AT DIVERSION SITES BY TYPES OF ACQUISITION

Diversion Site	Maximum Design Flow (CFS)	Type of Acquisition (Acres)			
		Fee	Perpetual Channel and Levee Right-of-Way	Perpetual Easement for disposal	Temporary Construction Easement
Bayou Lasseigne	10,650	5.0	241.0	407.2	6.0
	7,100	4.3	208.0	352.0	5.6
	5,325	4.0	178.0	303.0	5.4
	3,550	3.7	144.0	246.0	5.2
Bayou Fortier	10,650	4.1	288.0	488.0	8.3
	7,100	3.5	237.0	380.0	7.5
	5,325	3.2	207.0	349.0	7.0
	3,550	3.0	164.0	275.0	6.5
Davis Pond	10,650	6.0	379.5	2,975.0*	7.0
Oakville	5,325	2.4	117.0	157.0	3.1
	3,550	1.3	90.0	124.0	2.4
Big Mar	6,600	2.8	47.8	2048.2*	2.3
	4,400	2.2	37.0	2055.0**	2.3
	2,200	1.5	29.8	2055.2***	2.3
Mrytle Grove	5,325	2.4	217.1	297.1	3.1
	3,550	1.3	212.6	289.3	2.4

* Perpetual Flowage Easement - 2800.0 acres
** Perpetual Flowage Easement - 2003.0 acres
*** Perpetual Flowage Easement - 2020.0 acres
**** Perpetual Flowage Easement - 2027.0 acres

lands needed for access during construction. Lengths and widths of rights-of-way required are shown on plates C-19 through C-4. Land values are based on real estate appraisals as of October 1983. Estimated first costs for the lands and damages are shown in tables C-2-25 to C-2-30.

OPERATION AND MAINTENANCE

C.2.25. A designated interagency group would operate and maintain diversion structures. Estimates of costs for operation and maintenance are based on the assumption that all the diversion structures except for the Davis Pond structure would operate from January through April. The Davis Pond would operate from January through May. All structures are assumed to divert water 78 percent of the time during the diversion period. The diversion structures would be capable of passing the maximum design flow during a drought with a recurrence interval of once every ten years. The estimate of sediment to be dredged from the outflow channels is based on the sediment disposition exceedance curves shown in plate C-42. The operation cost of each structure is estimated at $500 per year. This is for an operator to open and close the structure. Routine maintenance costs are estimated at $200 per year per structure and include but are not limited to ground maintenance, greasing, painting, and removing debris at the structure. Major maintenance for each structure is estimated at $250,000 every 15 years and includes dewatering structures to replace valves, painting and repairing machinery, electrical systems, and the handrails. Levee maintenance will require the addition of 439,000 cubic yards of dredged material in the 2nd, 3rd, 5th, 10th, and 20th year at an annual cost estimated at $129,300. Annual dredging maintenance costs for the channels are shown in table C-2-31. Diversion of Mississippi River water may increase average annual dredging in Southwest Pass by 112,000 cubic yards at an estimated cost of $90,000.

TABLE C-2-25

SUMMARY OF PERTINENT DATA AND FIRST COSTS FOR LANDS AND DAMAGES

Bayou Lasseigne Site, Mile 141.1

Cost Acct. No.	Item	Unit / Unit Price	Maximum Design Flow (CFS) 10,650	7,100	5,325	3,550
01.	Lands and damages					
	Structures & Bridges	Acres	5.0	4.3	4.0	3.7
	Agricultural	Cost (1)	$ 25.0	$ 21.5	$20.0	$18.5
	Channel R/W					
	Agricultural	Acres	29.8	24.7	21.8	19.2
		Cost	$149.0	$123.5	$ 109	$96.0
	Woodland	Acres	144.6	125.6	107.0	85.7
		Cost	$ 72.3	$ 62.8	$ 53.5	$42.9
	Marshland	Acres	66.6	57.9	49.2	39.1
		Cost	$ 16.6	$ 14.5	$ 12.3	$ 9.8
	Disposal Area (2)					
	Agricultural	Acres	50.4	41.8	37.2	32.8
		Cost	$189.0	$156.8	$139.5	$123.0
	Woodland	Acres	244.4	212.4	182.0	146.3
		Cost	$ 91.6	$ 79.7	$68.3	$54.9
	Marshland	Acres	112.4	97.8	83.8	66.9
		Cost	$ 21.1	$ 18.3	$15.7	$12.5
	Construction Easement (3)	Acres	6.0	5.6	5.4	5.2
	Agricultural	Cost	$ 6.0	$ 5.6	$5.4	$5.2
	Improvements		0	0	0	0
	Severance Damage		0	0	0	0
Subtotal Lands and Damages		Acres	659.2	570.1	490.4	398.9
Cost			$570.6	$482.7	$423.7	$362.8
Contingencies (+25)			143.4	121.3	106.3	91.2
Acquisition Cost (15 Tracts)						
Non-Federal			$ 21.0	$ 21.0	$ 21.0	$ 21.0
Federal			$ 11.0	$ 11.0	$ 11.0	$ 11.0
Total First Cost			$746.0	$636.0	$562.0	$486.0
TOTAL ROUNDED			$746.0	$636.0	$562.0	$486.0

(1) Thousands of Dollars (2) Permanent (3) Temporary

TABLE C-2-26

SUMMARY OF PERTINENT DATA AND FIRST COSTS FOR LANDS AND DAMAGES

Bayou Fortier Site, Mile 132.0

Item	Unit / Unit Price	Maximum Design Flow (CFS) 10,650	7,100	5,325	3,550
nds and Damages					
Structure & Bridges					
Agricultural	Acres	4.1	3.5	3.2	3.0
	Cost (1)	$ 20.5	$ 17.5	$ 16.0	$ 15.0
Channel R/W	Acres	28.9	23.9	21.3	17.9
Agricultural	Cost	$144.5	$119.5	$106.5	$ 89.5
Woodland	Acres	167.4	137.1	119.1	93.5
	Cost	$ 83.7	$ 68.6	$ 59.6	$ 46.7
Marshland	Acres	91.7	76.0	66.6	52.7
	Cost	$ 22.9	$ 19.0	$ 16.7	$ 13.1
Disposal Area (2)					
Agricultural	Acres	49.1	38.1	35.7	30.1
	Cost	$184.1	$142.9	$133.9	$112.9
Woodland	Acres	283.6	219.9	200.9	156.6
	Cost	$106.4	$ 82.5	$ 75.3	$ 58.7
Marshland	Acres	155.3	122.0	112.4	88.3
	Cost	$ 29.1	$ 22.9	$ 21.0	$ 16.7
ction Easement (3)					
	Acres	8.3	7.5	7.0	6.5
cultural	Cost	$ 8.3	$ 7.5	$ 7.0	$ 6.5
ovements		0	0	0	0
rance Damage		0	0	0	0
otal	Acres	788.4	628.0	566.2	448.0
	Cost	$ 599.5	$ 480.4	$436.0	$359.1
ingencies (+25%)		$ 150.5	$ 119.6	$ 109	$ 89.9
isition Cost (12 Tracts)					
-Federal)		$ 17.0	$ 17.0	$ 17.0	$ 17.0
ral		8.0	$ 8.0	$ 8.0	$ 8.0
l First Cost		$ 775.0	$ 625.0	$570.0	$474.0
L ROUNDED		$ 775.0	$ 625.0	$570.0	$474.0

ousands of Dollars (2) Permanent (3) Temporary

TABLE C-2-27

SUMMARY OF PERTINENT DATA AND FIRST COSTS FOR LANDS AND DAMAGES

DAVIS POND SITE, MILE 118.4

Cost Acct No.	Item	Unit / Unit Price	Maximum Design Flow (CFS) 10,650
01.	Lands and Damages		
	Structures and bridges	Acres	5
		Cost	$40,000
	Pumping Station	Acres	1.0
		Cost	$2,000
	Channel R/W		
	Industrial (Potential)	Acres	26.5
		Cost	$212,000
	Woodland	Acres	10
		Cost	$20,000
	Woodland	Acres	55
		Cost	$44,000
	Perpetual Levee R/W		
	Industrial (Potential)	Acres	14.5
		Cost	$104,400
	Woodland	Acres	11.5
		Cost	$17,250
	Woodland	Acres	152
		Cost	$91,200
	Marsh	Acres	110
		Cost	$20,625
	Marsh Creation Area (Perpetual Disposal Area)		
	Marsh	Acres	175
		Cost	$32,813
	Flowage Easement		
	Woodland	Acres	2,500
		Cost	$750,000
	Marsh	Acres	300,000
		Cost	$15,000
	Improvement		0
	Severance Damage		0
	Construction Easement		
	(2 years)	Acres	7
	Industrial (Potential)	Cost	$11,200
	Subtotal		$1,360,438
	Contingencies (25±)		340,000
	Acquisition Costs (Estimated 7 ownerships)		
	Non-Federal		35,000
	Federal		7,000
	PL 91-646		0
	TOTAL		$1,742,000
	TOTAL ROUNDED		$1,742,000

State-owned land not included in above marsh:
4,450 acres @$250/acre x 0.20 — $222,500

TABLE C-2-28

SUMMARY OF PERTINENT DATA AND FIRST COSTS FOR LANDS AND DAMAGES

Oakville Site, Mile 70.4

Item	Unit / Unit Price	Maximum Design Flow (CFS) 5,325	3,550
s and Damages			
ructure & Bridges	Acres	2.4	1.3
sidential/Commercial	Cost (1)	$ 12.0	$ 6.5
nel R/W			
sidential/Commercial	Acres	12.8	10.9
	Cost	$ 64.0	$ 54.5
[illegible]	Acres	29.0	20.2
	Cost	$ 14.5	$ 10.1
[illegible]	Acres	75.2	58.9
	Cost	$ 37.6	$ 29.5
sposal Area (2)	Acres	17.2	15.1
sidential/Commercial	Cost	$ 64.5	$ 56.6
[illegible]	Acres	39.0	27.8
	Cost	$ 14.6	$ 10.2
[illegible]	Acres	100.8	81.1
	Cost	$ 37.8	$ 30.4
nstruction Easement (3)	Acres	3.1	2.4
sidential/Commercial	Cost	$ 3.1	$ 2.4
provements		$142.0	$142.0
verance Damage		0	0
Subtotal	Acres	279.5	217.7
	Cost	$390.0	$342.0
ntingencies (+25%)		$ 98.0	$ 86.0
quisition Cost (12 Tracts)			
on-Federal)		$ 22.0	$ 22.0
ederal)		$ 11.0	$ 11.0
L 91-646		$ 65.0	$ 65.0
otal First Cost		$586.0	$526.0
OTAL ROUNDED		$586.0	$526.0

housands of dollars (2) Permanent (3) Temporary

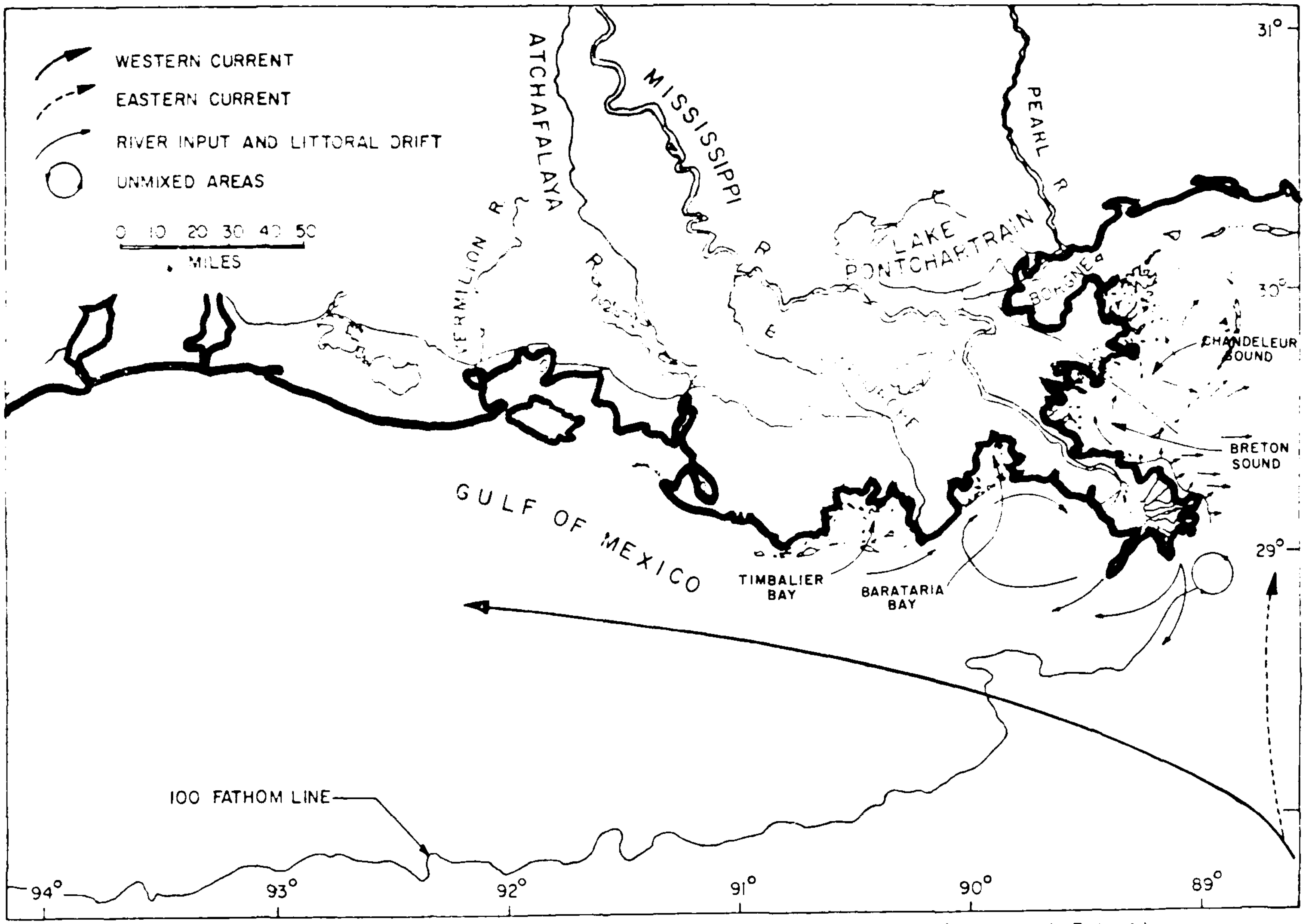
TABLE C-2-29

SUMMARY OF PERTINENT DATA AND FIRST COSTS FOR LANDS AND DAMAGES

Big Mar Site, Mile 81.5 (East Bank)

Cost Acct. No.	Item	Unit	Maximum Design Flow (CFS)		
		Unit Price	6,600	4,000	2,200
01.	Lands and Damages				
	Structure & Bridges	Acres	2.8	2.2	1.5
	Industrial	Cost (1)	$ 14.0	$11.0	$ 7.5
	Channel R/W	Acres	4.1	3.1	2.6
	Industrial	Cost	$ 20.5	$15.5	$13.0
	Woodland	Acres	14.4	11.3	9.2
		Cost	$ 7.2	$ 5.6	$ 4.6
	Marshland	Acres	29.3	22.6	18.0
		Cost	$ 2.9	$ 2.3	$ 1.8
	Dike (2)	Acres	29.0	29.0	29.0
	Marshland	Cost	$ 2.9	$ 2.9	$ 2.9
	Disposal Area (3)	Acres	3.9	2.9	2.4
	Industrial	Cost	$ 14.6	$10.9	$ 9.0
	Woodland	Acres	13.6	10.7	8.8
		Cost	$ 5.1	$ 4.0	$ 3.3
	Marshland	Acres	27.7	21.4	17.0
		Cost	$ 2.1	$ 1.6	$ 1.3
	Flowage Easement (2)	Acres	2,003.0	2,020.0	2,027.0
	Marshland	Cost	$ 50.1	$50.5	$50.7
	Construction Easement (3)				
	Industrial	Acres	2.3	2.3	2.3
	Improvements	Cost	$ 2.3	$ 2.3	$ 2.3
	Improvements		0	0	0
	Severance Damage		0	0	0
	Subtotal	Acres	2,130.1	2,125.5	2,117.8
		Cost	$122.0	$106.6	$96.4
	Contingencies (+25%)		$ 31.0	$ 27.4	$23.6
	Acquisition Cost (6 Tracts)				
	(Non-Federal)		$ 8.0	$ 8.0	$ 8.0
	(Federal)		$ 4.0	$ 4.0	$ 4.0
	Total First Cost		$165.0	$146.0	$132.0
	TOTAL ROUNDED		$165.0	$146.0	$132.0

(1) Thousands of Dollars (2) Permanent (3) Temporary



GENERALIZED SURFACE CIRCULATION ALONG LOUISIANA CONTINENTAL SHELF (FROM STONE, 1972)

PLATE C-I

prevent water from entering Caernarvon Canal. The control structure contains nine 5' x 20' box culverts and is 100 feet long. The inlet channel would be 800 feet long with a bottom width of 200' and side slopes of 1 on 3. The outlet channel would be 8,100 feet long with a bottom width of 180 feet and side slopes of 1 on 3. The dike would have a 5-foot crown, 1 on 3 side slopes, elevations varying between 3 and 5 feet NGVD, and would extend along the east bank of the Caernarvon Canal. Riprap would be placed in the inflow channel at the Mississippi River, in the outflow channel at the structure, and 100' feet above and below the crossings.

C.2.32 Under the recommended cost share arrangement between the Federal Government and the non-Federal interests of 75 and 25 percent, respectively, the Federal cost is $35,600,000 and the non-Federal cost is $11,800,000. The average annual operation and maintenance cost is $545,000 and will be entirely borne by the non-Federal interests.

TABLE C-2-40

FIRST COST SUMMARY OF ALTERNATIVE PLANS

Alternative Plan No.	Diversion Site	Maximum Design Flow (CFS)	First Cost 1/ $1,000
1	Big Mar	6,600	$14,000
	Bayou Fortier	7,100	22,000
	Bayou Lasseigne	3,550	13,500
	Totals		$49,500
2	Big Mar	6,600	$14,000
	Bayou Fortier	3,550	13,900
	Bayou Lasseigne	7,100	20,400
	Totals		$48,300
3	Big Mar	6,600	$14,000
	Bayou Fortier	5,325	18,600
	Bayou Lasseigne	5,325	16,900
	Totals		$49,500
4	Big Mar	6,600	$14,000
	Bayou Fortier	10,650	29,200
	Totals		$43,200
5	Big Mar	6,600	$14,000
	Bayou Lasseigne	10,650	25,800
	Totals		$39,800
6	Big Mar	6,600	$14,000
	Oakville	5,325	10,000
	Bayou Fortier	5,325	18,600
	Totals		$42,600
7	Big Mar	6,600	$14,000
	Oakville	5,325	10,000
	Bayou Lasseigne	5,325	16,900
	Totals		$40,900
8	Big Mar	6,600	$14,000
	Oakville	3,550	7,300
	Bayou Fortier	7,100	22,000
	Totals		$43,300
9	Big Mar	6,600	$14,000
	Oakville	3,550	7,300
	Bayou Lasseigne	7,100	20,400
	Totals		$41,700
10	Big Mar	6,600	$14,000
	Oakville	3,550	7,300
	Bayou Fortier	3,550	13,900
	Bayou Lasseigne	3,550	13,500
	Totals		$48,700
11	Big Mar	6,600	$14,000
	Myrtle Grove	5,325	11,400
	Bayou Fortier	5,325	18,600
	Totals		$44,000
12	Big Mar	6,600	$14,000
	Myrtle Grove	5,325	11,400
	Bayou Lasseigne	5,325	16,900
	Totals		$42,300
13	Big Mar	6,600	$14,000
	Bayou Fortier	7,100	22,000
	Myrtle Grove	3,550	8,700
	Totals		$44,700
14	Big Mar	6,600	$14,000
	Myrtle Grove	3,550	8,700
	Bayou Lasseigne	7,100	20,400
	Totals		$43,100
15	Big Mar	6,600	$14,000
	Myrtle Grove	3,550	8,700
	Bayou Fortier	3,550	13,900
	Bayou Lasseigne	3,550	13,500
	Totals		$50,100
16	Big Mar	6,600	$14,000
	Davis Pond	10,650	29,000
	Totals		$43,000

1/ Preconstruction and postconstruction monitoring costs is not included.

freshwater from January through April and one plan, which included the Davis Pond site, that would divert water January through May to maintain the desired salinity gradients from the period April through September in Breton Sound and Barataria Basins. The freshwater diverted through the structures would maintain the desired salinity gradients during droughts with frequencies of up to once in ten years. The plans are described in Appendix B, Plan Formulation, and shown on plate B-2 of that appendix. The first costs of the 16 alternative plans are shown in table C-2-40. These costs do not include the preconstruction and postconstruction monitoring program.

RECOMMENDED PLAN

C.2.29 Plan 16 is the recommended plan. The plan provides for freshwater diversion to Barataria Basin near Davis Pond (plate C21) and Breton Sound Basin at Big Mar (plate C-24).

C.2.30. At the Davis Pond site, the control structure and inlet and outlet channels would be capable of passing 10,650 cfs. The control structure would be 240 feet long with six 15' x15' box culverts. The bottom widths of the inlet and outlet channels would be 200 feet. Side slopes of the channel would be 1 on 3. The inlet channel would be 520 feet long and the outlet channel, 11,250 feet. There are approximately 3.5 miles of channel guide levees with heights varying from 3 to 6 feet and approximately 11.9 miles of guide levees for the impoundment with heights from 3 to 4 feet. Immediately downstream of the structure at Davis Pond, 200 feet of riprap would be placed. Riprap would also be placed in the inflow channel at the Mississippi River, in the outflow channel at the structure, and 100' above and below the crossings at the Southern Pacific railroad and US Highway 90.

C.2.31 The diversion site at Big Mar would consist of a control structure and inlet and outlet channels capable of passing a design flow of 6,600 cfs. In addition, a dike about two miles long is provided to

TABLE C-2-39

SUMMARY OF FIRST COST FOR FRESHWATER DIVERSION

Big Mar Site, Mile 81.5 (East Bank)

Cost Acct. No.	Item	Maximum Design Flow (CFS) 6,600	4,400	2,200
		(Thousands of Dollars)		
01.	Lands and damages	$122	$107	$96
	Acquisition	12	12	12
	Contingencies	31	27	24
	Subtotal	$165	$146	$132
02.	Relocations*			
	.1 Roads	282	268	222
	.4 Railroads	177	170	145
	.7 Pipelines	61	61	61
	Subtotal	520	499	428
09.	Channel*	610	454	305
11.	Levees*	66	66	66
15.	Diversion structure*	9,419	6,677	3,901
30.	Engineering and design	2,199**	881	523
31.	Supervision and administration	1,049	755	450
	TOTAL First Cost	$14,028	$9,478	$5,805
	TOTAL ROUNDED	$14,000	$9,500	$5,800

*Includes contingencies.

**Based on preconstruction planning estimate for Caernarvon dated 14 February 1983; includes E&D and S&A during construction.

SUMMARY OF FIRST COST FOR FRESHWATER DIVERSION AT MYRTLE GROVE

Myrtle Grove Site, Mile 58.7

Cost Acct. No.	Item	Maximum Design Flow (CFS) 5,325	3,550
		(Thousands of Dollars)	
01.	Lands and damages	$299	$262
	Acquisition cost	9	9
	Contingencies	75	66
	PL-91-646	4	4
	Subtotal	$387	$341
02.	Relocations*		
	.1 Roads	$435	$435
	.4 Railroads	383	383
	.7 Pipelines	156	108
	Subtotal	$968	$926
09.	Channels and canals*	$2,230	$2,020
11.	Levee setback	$408	$408
15.	Diversion structure*	$5,600	$3,700
30.	Engineering and design	917	664
31.	Supervision and administration	854	632
	TOTAL First Cost	$11,364	$8,691
	TOTAL ROUNDED	$11,400	$8,700

*Includes contingencies.

TABLE C-2-37

SUMMARY OF FIRST COST FOR FRESHWATER DIVERSION

OAKVILLE SITE, MILE 70.4

Cost Acct No.	Item	Maximum Design Flow (CFS) 5,325	3,550
		(Thousands of Dollars)	
01.	Lands and Damages	$390	$342
	Acquisition Cost	33	33
	Contingencies	98	86
	PL-91-646	65	65
	Subtotal	$586	$526
02.	Relocations*		
	.1 Roads	$435	$435
	.4 Railroads	383	383
	.7 Pipelines	100	72
	Subtotal	$918	$890
09.	Channel*	$1,870	$1,240
11.	Levees*	408	408
15.	Diversion Structure*	4,718	3,130
30.	Engineering and Design	780	545
31.	Supervision and Administration	733	513
	TOTAL FIRST COST	$10,013	$7,252
	TOTAL ROUNDED	$10,000	$7,300

*Includes contingencies.

TABLE C-2-36

SUMMARY OF FIRST COST FOR FRESHWATER DIVERSION

Davis Pond Site, Mile 118.4

Cost Acct No.	Item	Maximum Design Flow (CFS) 10,650
		(Thousands of Dollars)
01.	Lands and Damages	$1,369
	Acquisition Cost	42
	Contingencies	340
	Subtotal	$1,742
02.	Relocations	
	.1 Roads	$2,128
	.4 Railroads	2,768
	.7 Pipelines	1,399
	Subtotal	$6,295
09.	Channels*	$2,570
11.	Levees*	$2,520
15.	Diversion Structure, Weirs & Pumping Station*	11,714
30.	Engineering and Design	$2,140
31.	Supervision and Administration	2,004
	TOTAL FIRST COST	$28,985
	TOTAL ROUNDED	$29,000

*Includes contingencies

TABLE C-2-35

SUMMARY OF FIRST COST FOR FRESHWATER DIVERSION

Bayou Fortier Site, Mile 132.0

Cost Acct. No.	Item	Maximum Design Flow (CFS) 10,650	7,100	5,325	3,550
		Thousands of Dollars			
01.	Lands and damages	$600	$480	$436	359
	Acquisition cost	25	25	25	25
	Contingencies	150	120	109	90
	Subtotal	775	625	570	474
02.	Relocations*				
	.1 Roads	2,659	2,257	1,989	1,526
	.4 Railroads	1,831	1,707	1,625	1,263
	.7 Pipelines	672	530	485	374
	Subtotal	5,162	4,494	4,099	3,163
09.	Channel*	7,940	5,330	4,280	2,610
15.	Diversion structure*	10,987	8,302	6,915	5,595
30.	Engineering and design	2,183	1,642	1,379	1,050
31.	Supervision and administration	2,124	1,623	1,358	1,007
	TOTAL First Cost	$29,171	$22,016	$18,601	$13,899
	TOTAL ROUNDED	$29,200	$22,000	$18,600	$13,900

*Includes contingencies

TABLE C-2-34

SUMMARY OF FIRST COST FOR FRESHWATER DIVERSION

Bayou Lasseigne Site, Mile 141.1

Cost Acct. No.	Item	Maximum Size Flow (CFS) 10,650	7,100	5,325	3,550
		(Thousands of Dollars)			
01.	Lands and damages	$571	$483	$424	$363
	Acquisition cost	32	32	32	32
	Contingencies	143	121	106	91
	Subtotal	746	636	562	486
02.	Relocations*				
	.1 Roads	$967	$811	$760	$710
	.4 Railroads	1,831	1,707	1,625	1,543
	.7 Pipelines	634	534	469	358
	Subtotal	3,432	3,052	2,854	2,611
09.	Channels *	6,690	5,400	4,060	2,810
15.	Diversion structure*	10,989	8,304	6,918	5,599
30.	Engineering and design	1,994	1,555	1,285	1,029
31.	Supervision and administration *	1,905	1,495	1,223	962
	TOTAL First Cost	$25,756	$20,442	$16,902	$13,497
	TOTAL ROUNDED	$25,800	$20,400	$16,900	$13,500

*Includes contingencies.

TABLE C-2-33

COST ESTIMATE FOR SAMPLING STATIONS AND TIDE GAGES

Barataria and Breton Sound Basins*

Item	Cost
Cost per sampling station	
Instrument	$5,000
Shelter	2,500
Solar panel and battery	450
Labor	500
Total per station	$8,450
Cost for 6 stations	$50,700
Data convertor	5,000
2 boats, motors and trailers	15,000
Cost for 6 tide gages	$134,000
TOTAL COST	$204,700
TOTAL ROUNDED	$205,000

*Included in preconstruction and postconstruction water quality monitoring costs.

TABLE C-2-31

AVERAGE ANNUAL DREDGING MAINTENANCE COST 1/

	Maximum Design Flows (CFS)						
Diversion Site	10,650	7,100	6,600	5,325	4,400	3,550	2,200
Bayou Lasseigne	$88,000	$73,400	-	$68,000	-	$57,300	-
Bayou Fortier	88,000	73,400	-	68,600	-	57,300	-
Davis Pond*	32,000	-	-	-	-	-	-
Oakville	-	-	-	42,500	-	35,400	-
Big Mar	-	-	19,100	-	12,700	-	6,400
Mrytle Grove	-	-	-	42,500	-	35,400	-

* Levee maintenance will require dredging estimated at $129,000 per year.

1/ The diversions may increase dredging costs in Southwest Pass by $90,000 per year.

TABLE C-2-32

PRECONSTRUCTION AND POSTCONSTRUCTION WATER QUALITY AND BIOLOGICAL MONITORING COSTS BY BASIN*

Basin	Preconstruction	Postconstruction	Total
Barataria Bay	$1,320,000	$1,760,000	$3,080,000
Breton Sound	556,000	741,000	1,297,000
Total	**$1,876,000**	**$2,501,000**	**$4,377,000**

* Includes contingency (25%) and Supervision and Administration (18%).

C.2.26. As part of the diversion project, a 3-year preconstruction and 4-year postconstruction water quality and biological monitoring program would be conducted to obtain information on the impacts of the freshwater diversion on the diversion. The monitoring project is not entirely dependent on the location of the diversion structure, but on basin configuration. The preconstruction and postconstruction cost by b sin is shown in table C-2-32.

C.2.27. In addition, sampling stations would be installed in the Barataria Bay and Breton Sound Basins to collect data that would be used in determining structure operation. The stations would record salinity tides, precipitation, temperature, wind speed, and direction. Estimates are that four sampling stations are required in the Barataria Basin, and two in the Breton Sound Basin. Approximate sampling station locations are shown in plate K-1, Appendix K, Operation Criteria. The installation cost for the six sampling stations and tide gages is $205,000 (table C-2-33). The average annual and maintenance cost associated with the sampling stations is $126,700 for Barataria Basin and $63,300 for Breton Sound Basin. Operation and maintenance costs are for routine maintenance of sensor devices at the stations, for personnel and equipment to collect and analyze the data, for analyses of the samples taken, and for interpretation of the analyses. These basin-wide costs associated with the preconstruction and postconstruction monitoring program and the sampling stations should be added to the first cost of each plan.

ALTERNATIVE PLANS CONSIDERED

C.2.28. The summaries of total first costs for the diversion sites are shown in tables C-2-34 through C-2-39. At each site, the diversion structures were designed to pass various maximum flows. These sites were combined to formulate 15 alternative plans that would divert

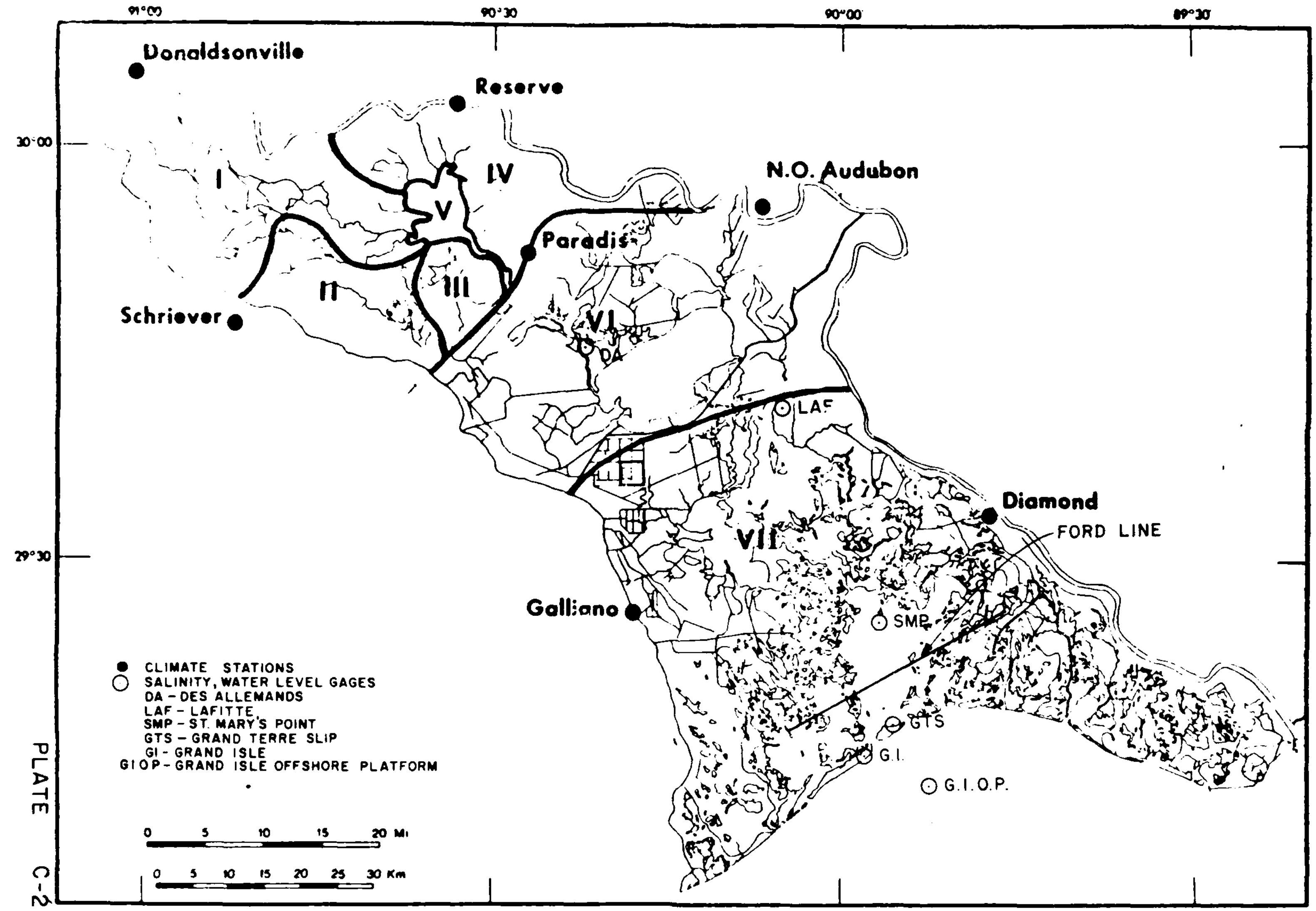
TABLE C-2-30

SUMMARY OF PERTINENT DATA AND FIRST COSTS FOR LANDS AND DAMAGES

Myrtle Grove, Mile 58.7

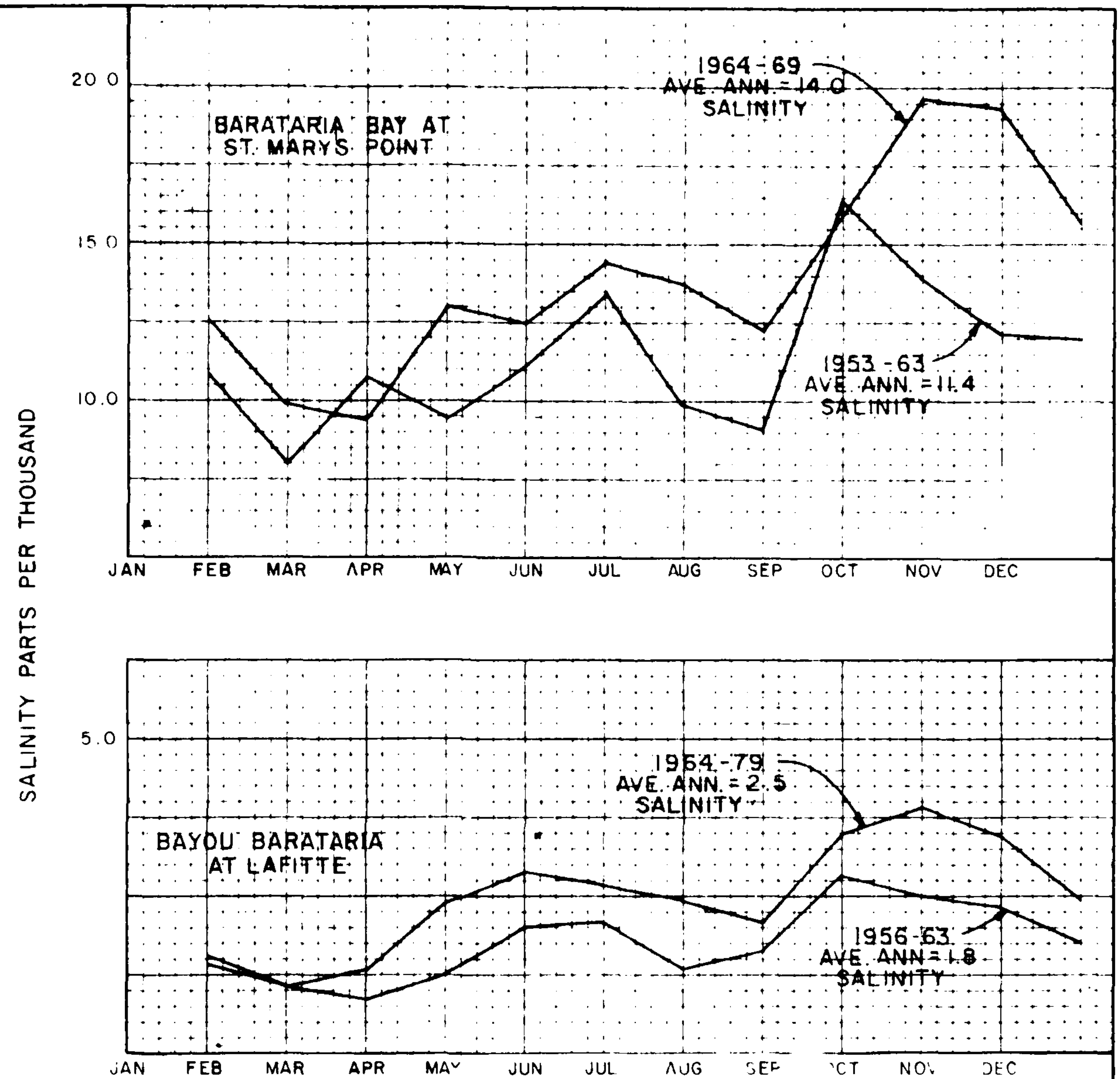
Cost Acct. No.	Item	Unit / Unit Price	Maximum Design Flow (CFS) 5,325	3,550
01.	Lands and Damages			
	Structure and Bridge			
	Levee Protected Land	Acres	2.4	1.3
		Cost (1)	$ 12.0	$ 6.5
	Channel R/W			
	Levee Protected Land	Acres	15.9	11.5
		Cost	$ 79.5	$ 57.5
	Marshland	Acres	10.9	10.9
		Cost	$ 2.7	$ 2.7
	Existing Channel R/W	Acres	190.3	190.3
		Cost	$ 0.0	$ 0.0
	Levee and Disposal (2)			
	Levee Protected Land	Acres	30.7	27.2
		Cost	$115.0	$102.1
	Marshland	Acres	201.4	223.1
		Cost	$ 37.7	$ 41.8
	Existing Levee & Disposal	Acres	39.0	39.0
		Cost	$ 0.0	$ 0.0
	Water Area	Acres	26.0	26.0
		Cost	$ 0.0	$ 0.0
	Construction Easement (3)			
	Levee Easement	Acres	3.1	2.4
		Cost	$ 3.1	$ 2.4
Improvement (7 Camps)		-	$ 49.0	$ 49.0
	Severance Damage		$ 0.0	$ 0.0
	Subtotal		$299.0	$ 262
	Contingencies (25%)		$ 75.0	$ 66
	Acquisition Cost (6 tracts)			
	(Non-Federal)		$ 6.0	$ 6.0
	(Federal)		$ 3.0	$ 3.0
	PL 91-646		$ 4.0	$ 4.0
	TOTAL		$387.0	$341.0
	TOTAL ROUNDED		$387.0	$341.0

(1) Thousands of Dollars (2) Permanent (3) Temporary



Location of climate stations and subbasins.

PLATE C-2

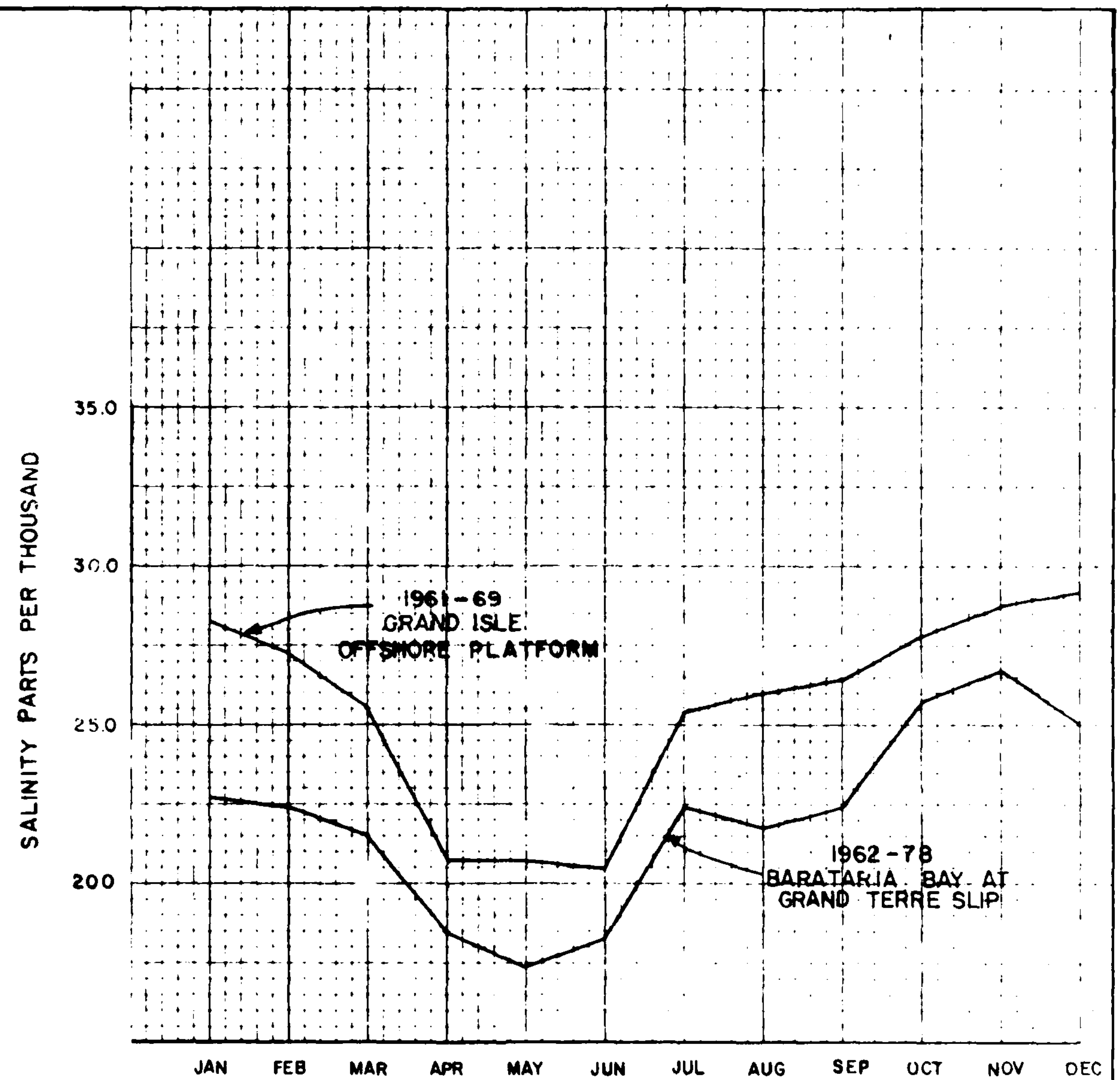


LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

AVERAGE MONTHLY SALINITY ST. MARY'S POINT AND LAFITTE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

APRIL 1982 FILE NO H-2-29437

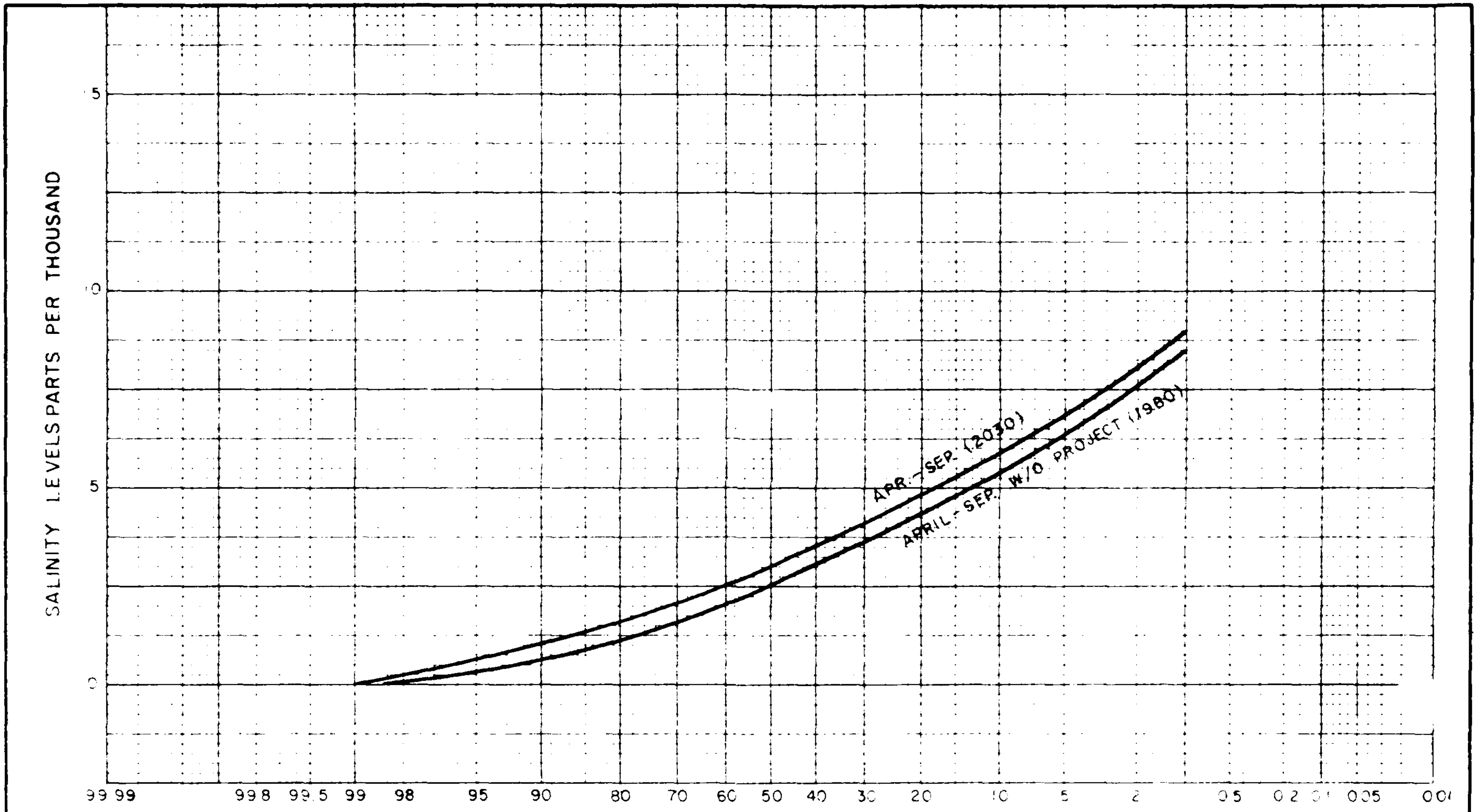


LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

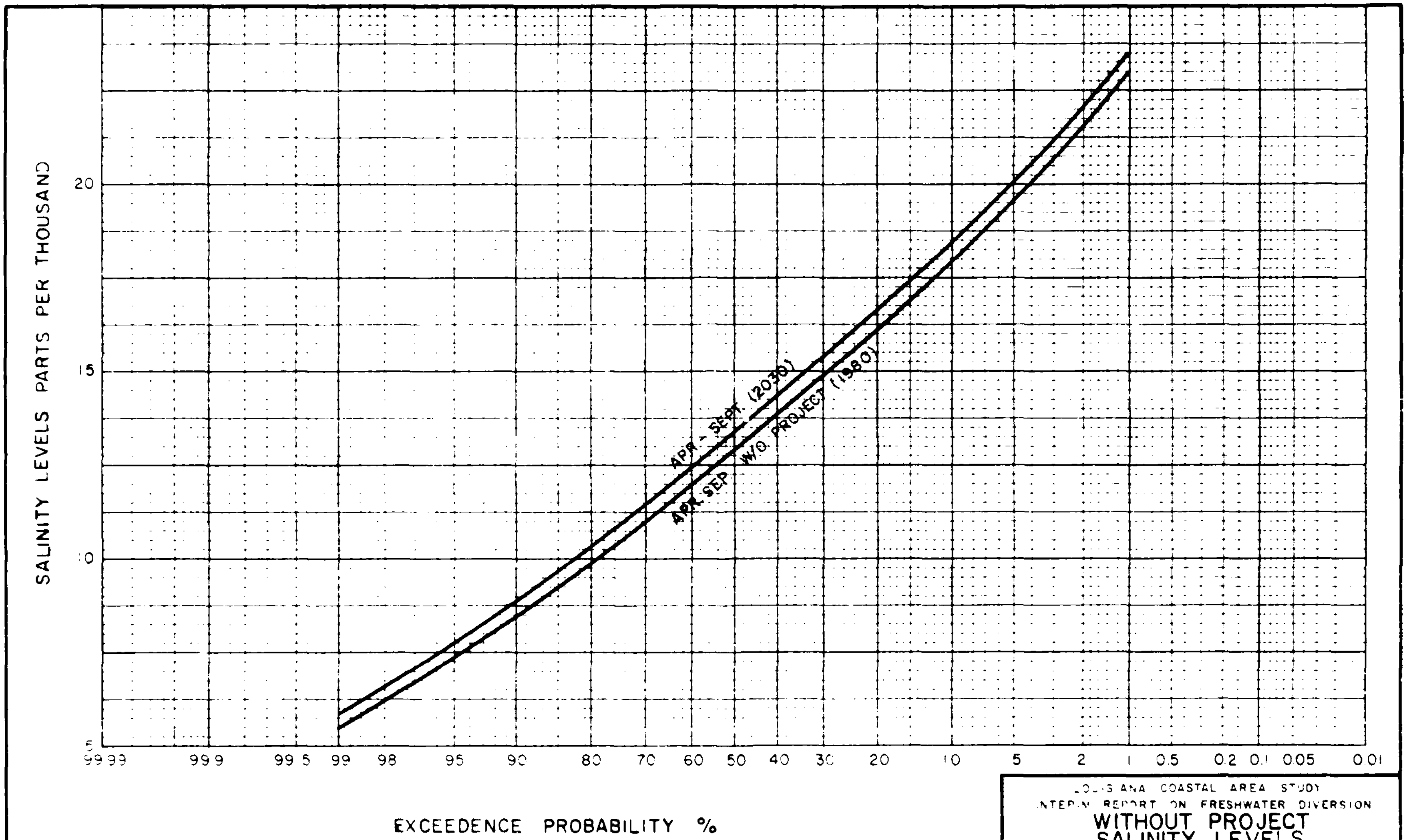
AVERAGE MONTHLY SALINITY
GRAND ISLE AND
GRAND TERRE SLIP

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

APRIL 1982 FILE NO H-2-29437



WITHOUT PROJECT
SALINITY LEVELS
1980 AND 2030
LAFITTE-BARATARIA WATERWAY



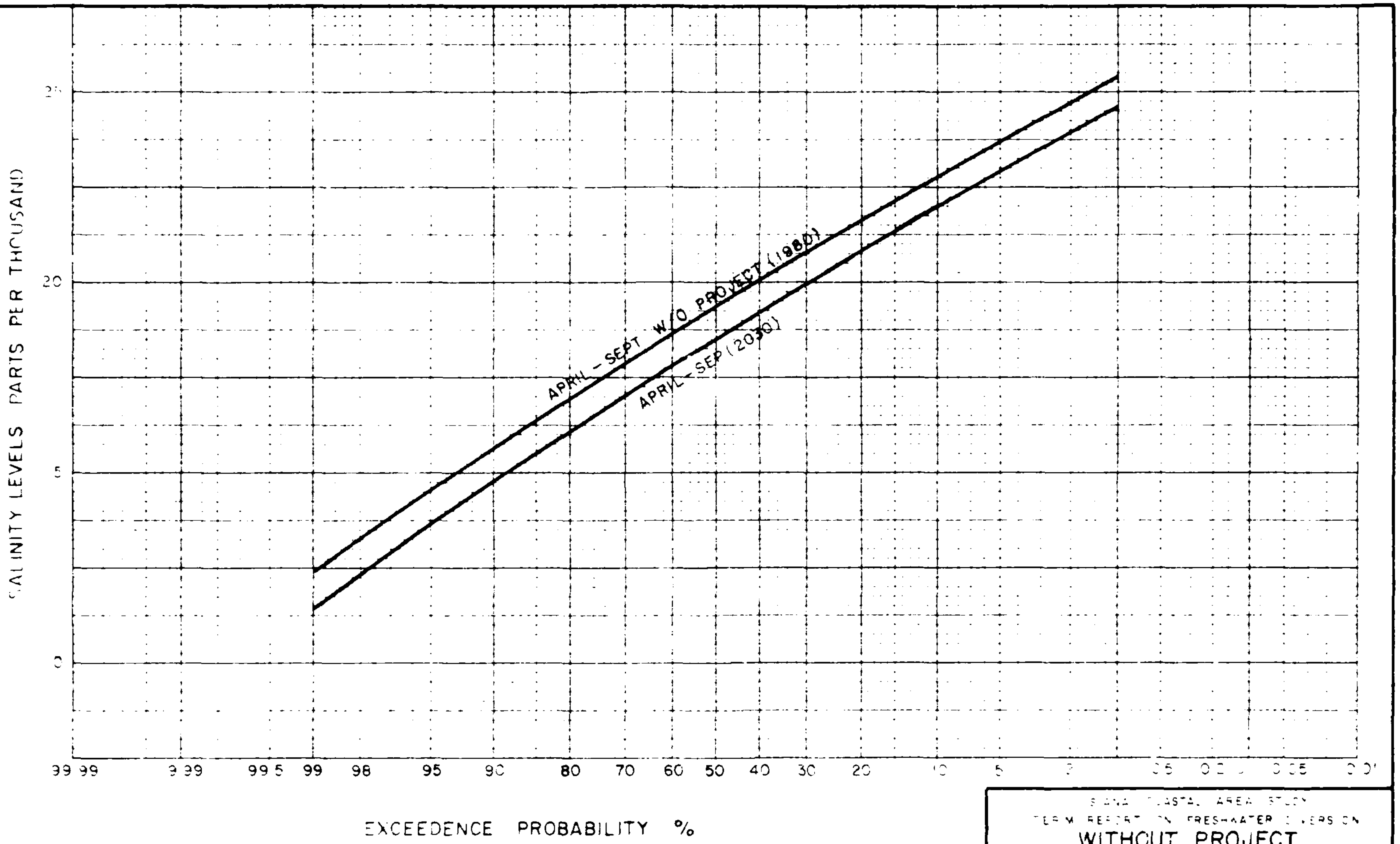
LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

WITHOUT PROJECT SALINITY LEVELS 1980 AND 2030

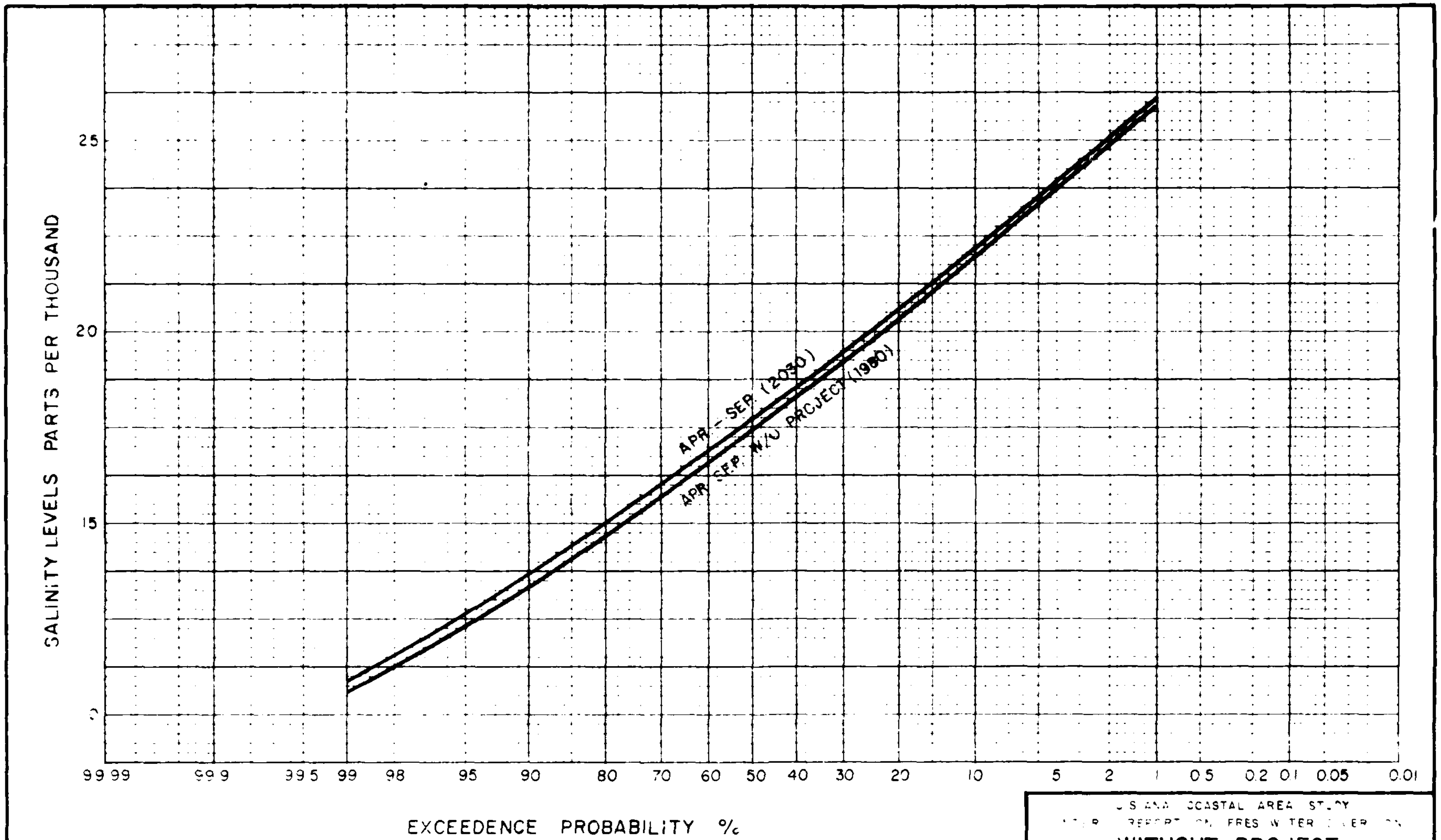
ST. MARY'S POINT-BARATARIA BAY

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

PLATE C-6



WITHOUT PROJECT
SALINITY LEVELS
1980 AND 2030
GRAND TERRE SLIP



U.S. AND COASTAL AREA STUDY

REPORT ON FRESH WATER DIVERSION

WITHOUT PROJECT SALINITY LEVELS 1980 AND 2030 FORD LINE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

APRIL 1982

PLATE C-8

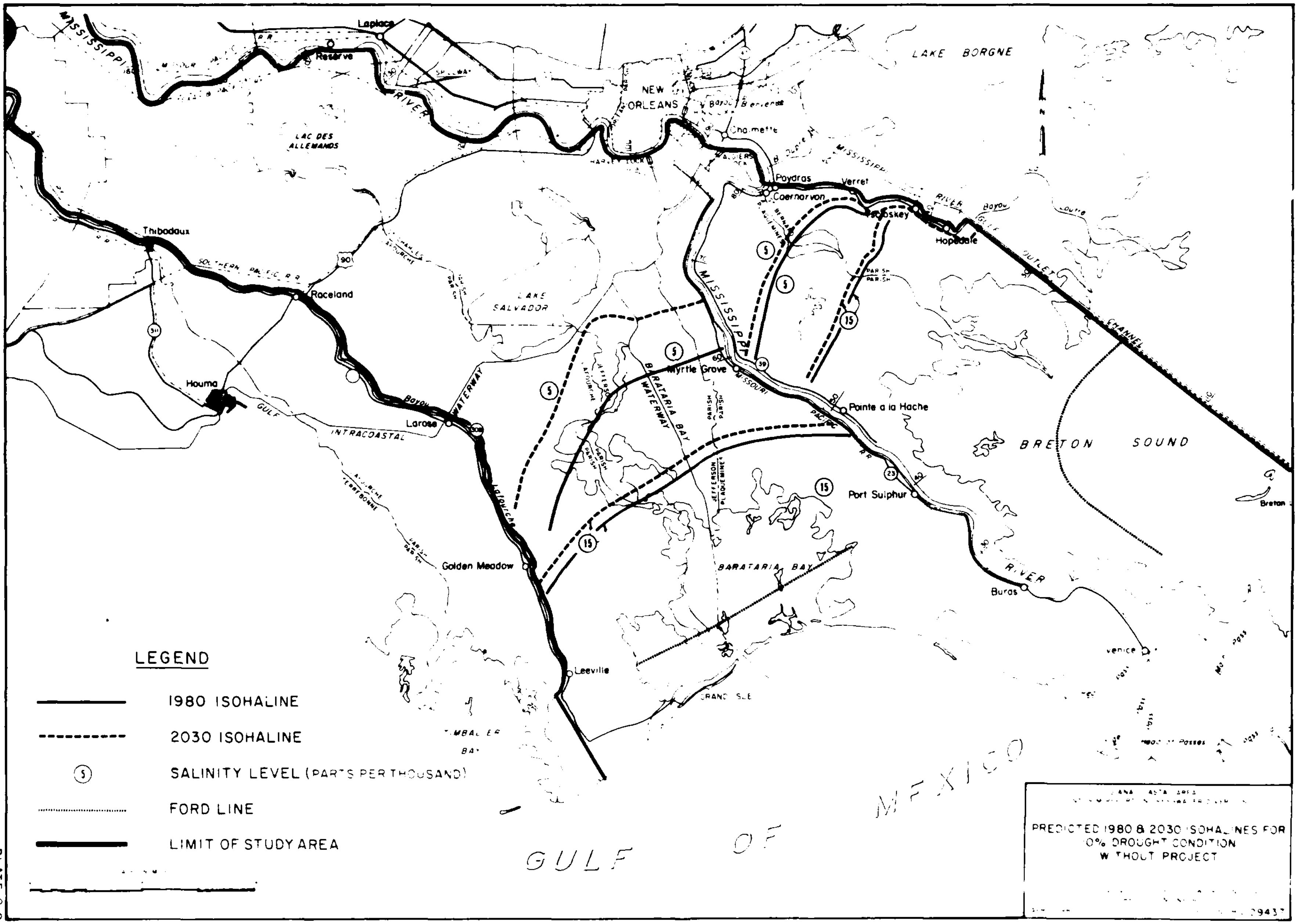
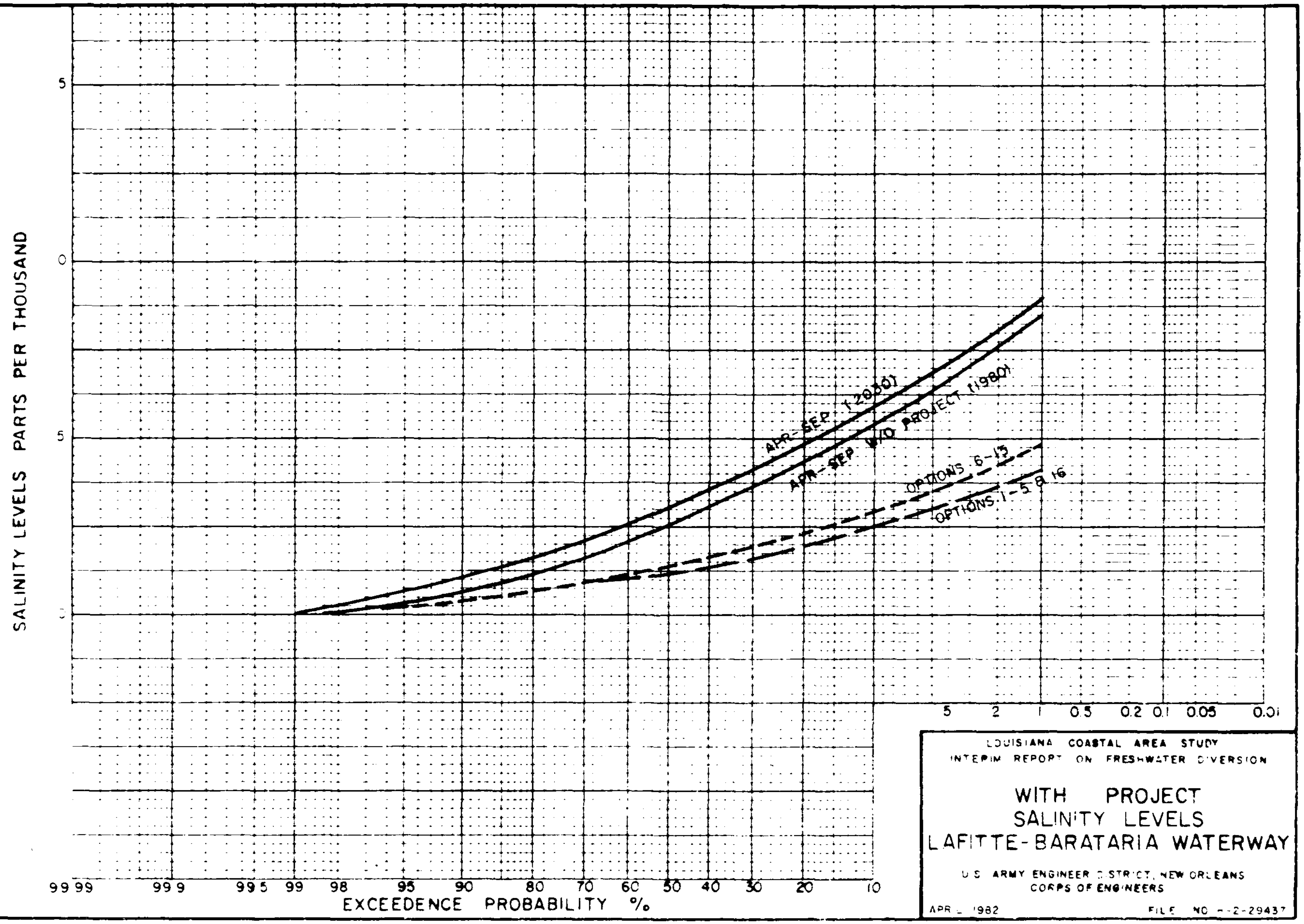

LAKE BORGNE
NEW ORLEANS
Laplace
Reserve
Chalmette
Poydras
Verret
Caernarvon
Hopedale
LAC DES ALLEMANDS
Thibodaux
Raceland
LAKE SALVADOR
Houma
Larose
INTRACOASTAL
WATERWAY
Golden Meadow
Leeville
MISSISSIPPI
RIVER
Myrtle Grove
BARATARIA BAY WATERWAY
Pointe a la Hache
Port Sulphur
Buras
BRETON SOUND
Breton
BARATARIA BAY
CHANNEL
OUTLET
GULF OF MEXICO
LEGEND
1980 ISOHALINE
2030 ISOHALINE
5 SALINITY LEVEL (PARTS PER THOUSAND)
FORD LINE
LIMIT OF STUDY AREA
PREDICTED 1980 & 2030 ISOHALINES FOR 10% DROUGHT CONDITION WITHOUT PROJECT

PLATE C-9



LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

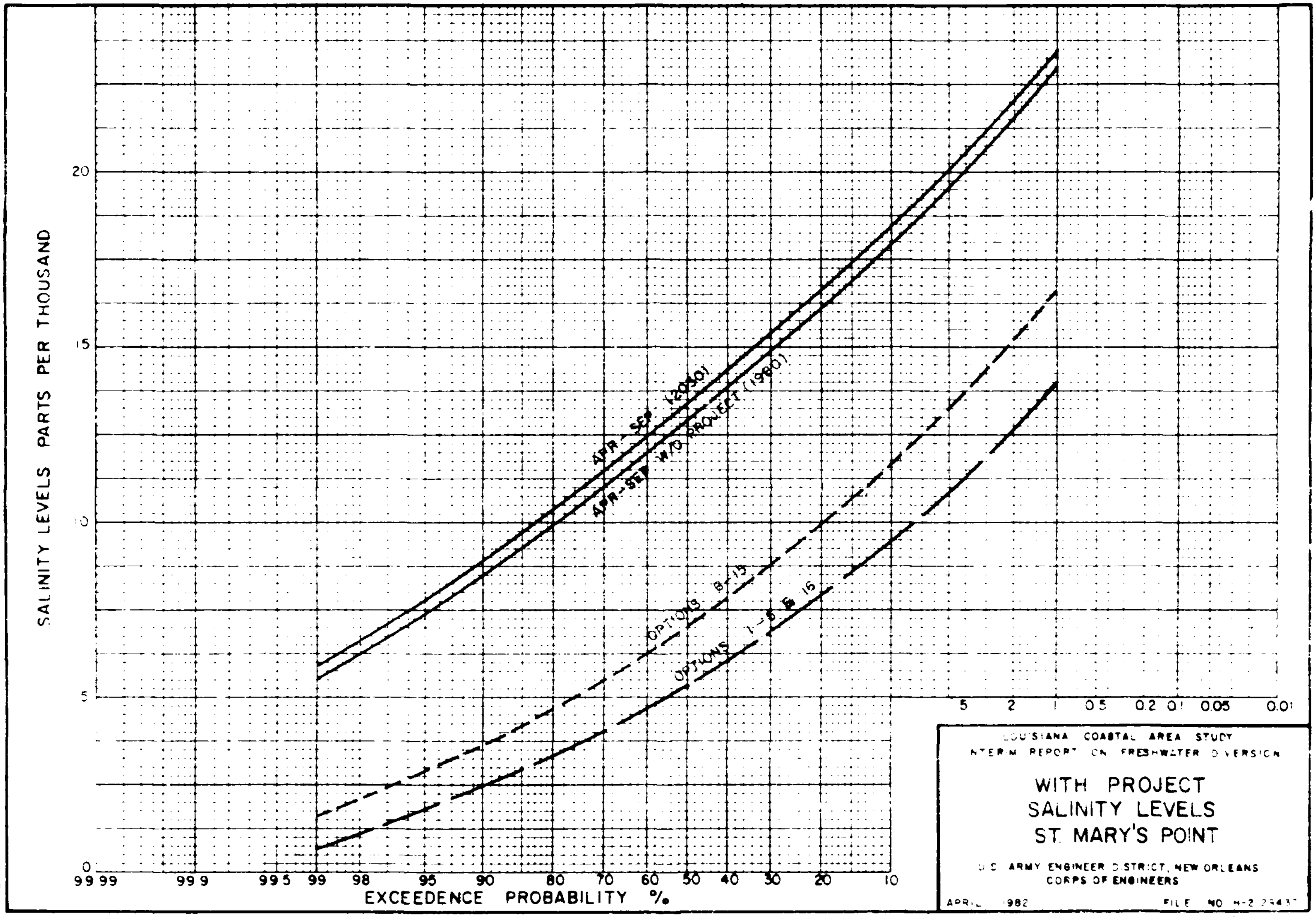
WITH PROJECT
SALINITY LEVELS
LAFITTE-BARATARIA WATERWAY

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

APRIL 1982

FILE NO. H-2-29437

PLATE C-10



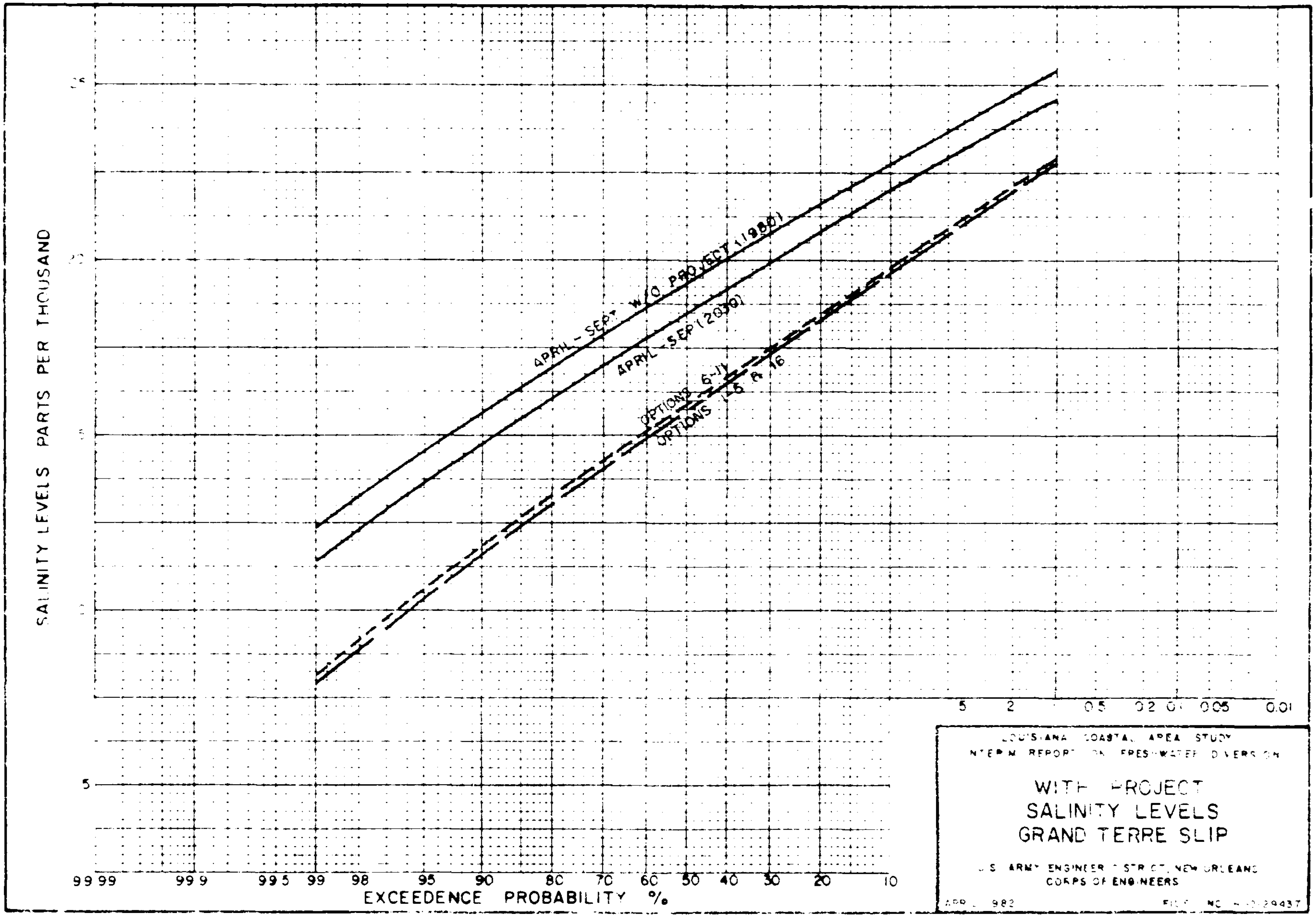
LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

WITH PROJECT
SALINITY LEVELS
ST. MARY'S POINT

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

APRIL 1982 FILE NO. H-2 23431

PLATE C-11

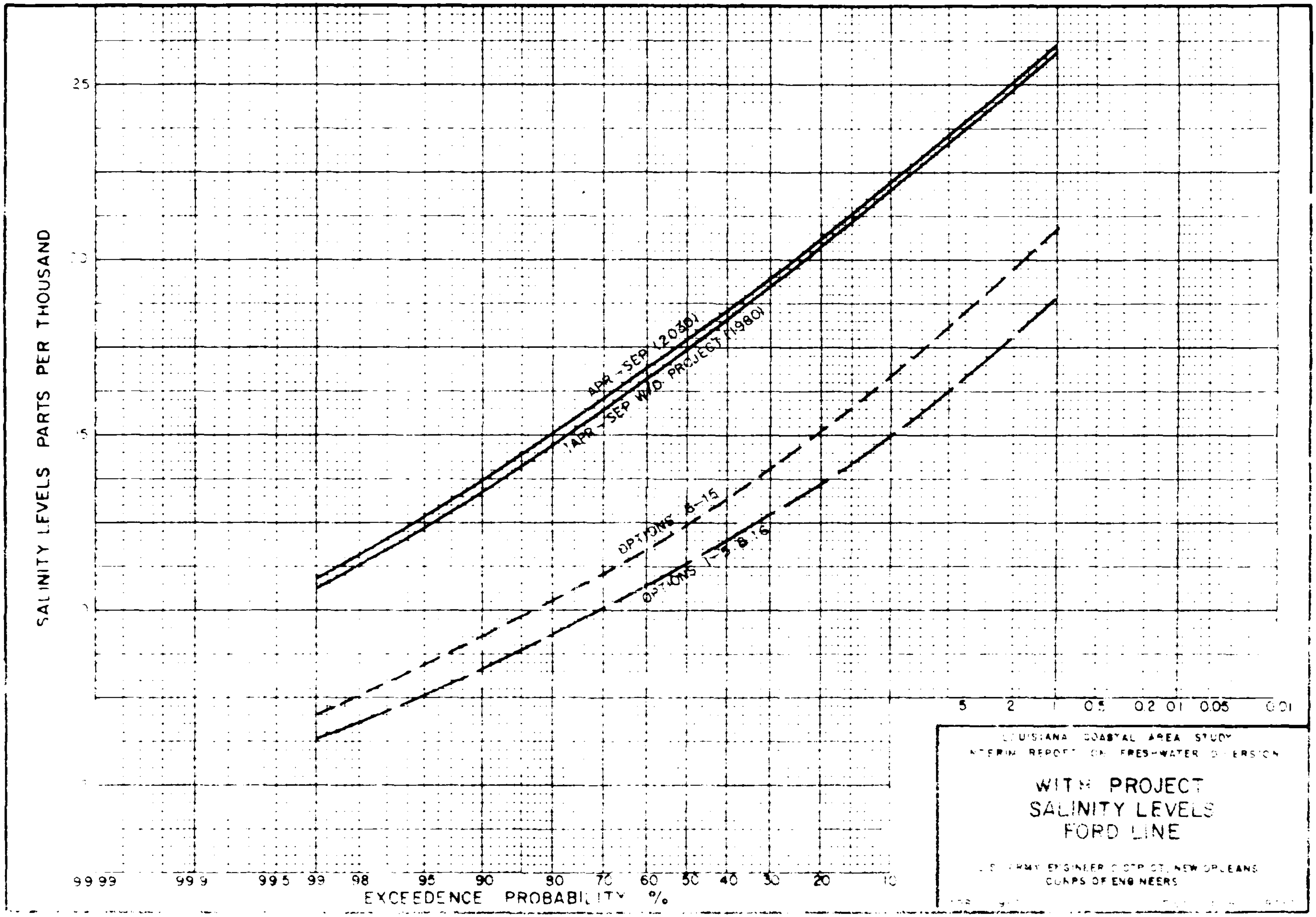


LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

WITH PROJECT
SALINITY LEVELS
GRAND TERRE SLIP

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

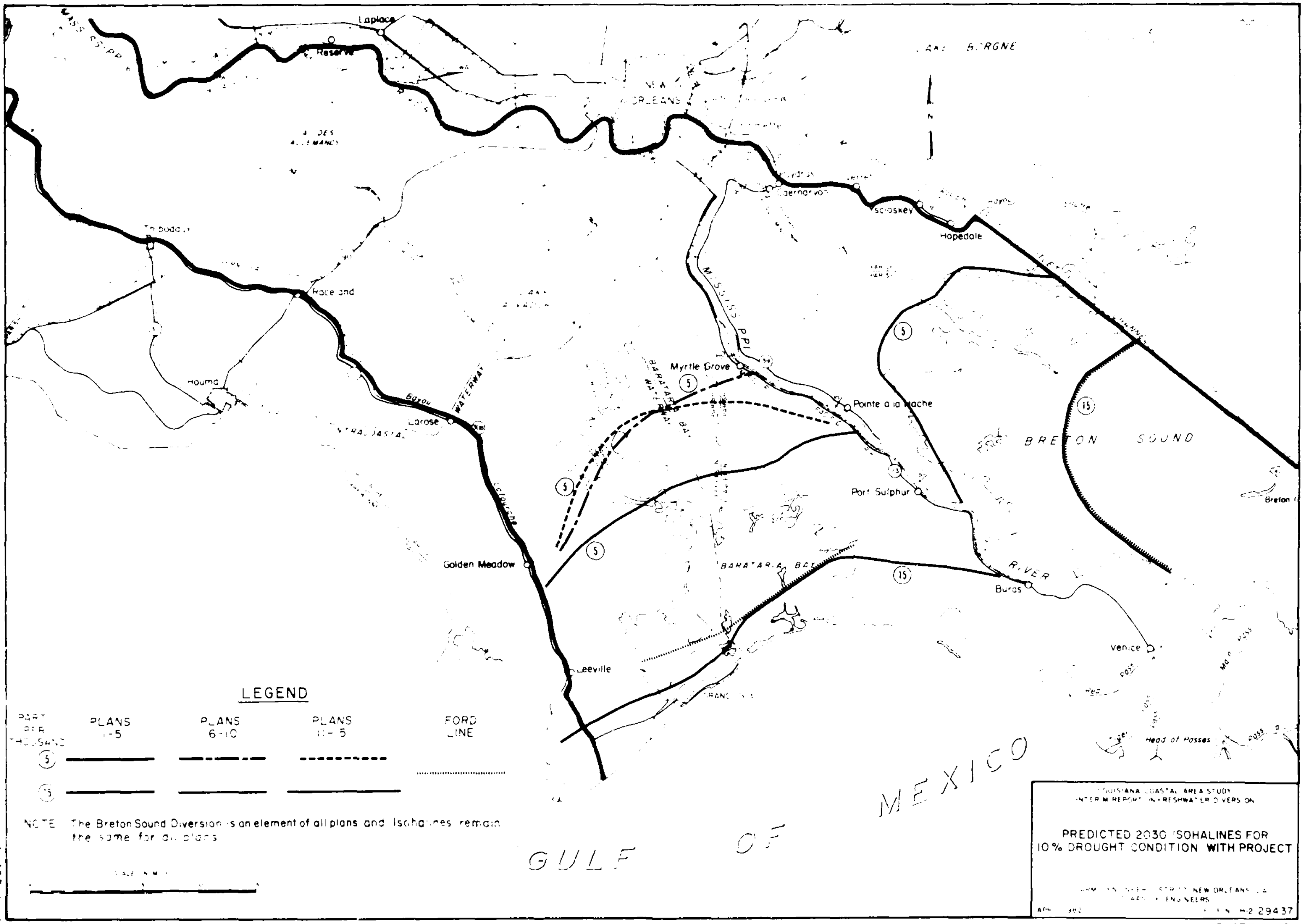
APRIL 1982



LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESH-WATER DIVERSION

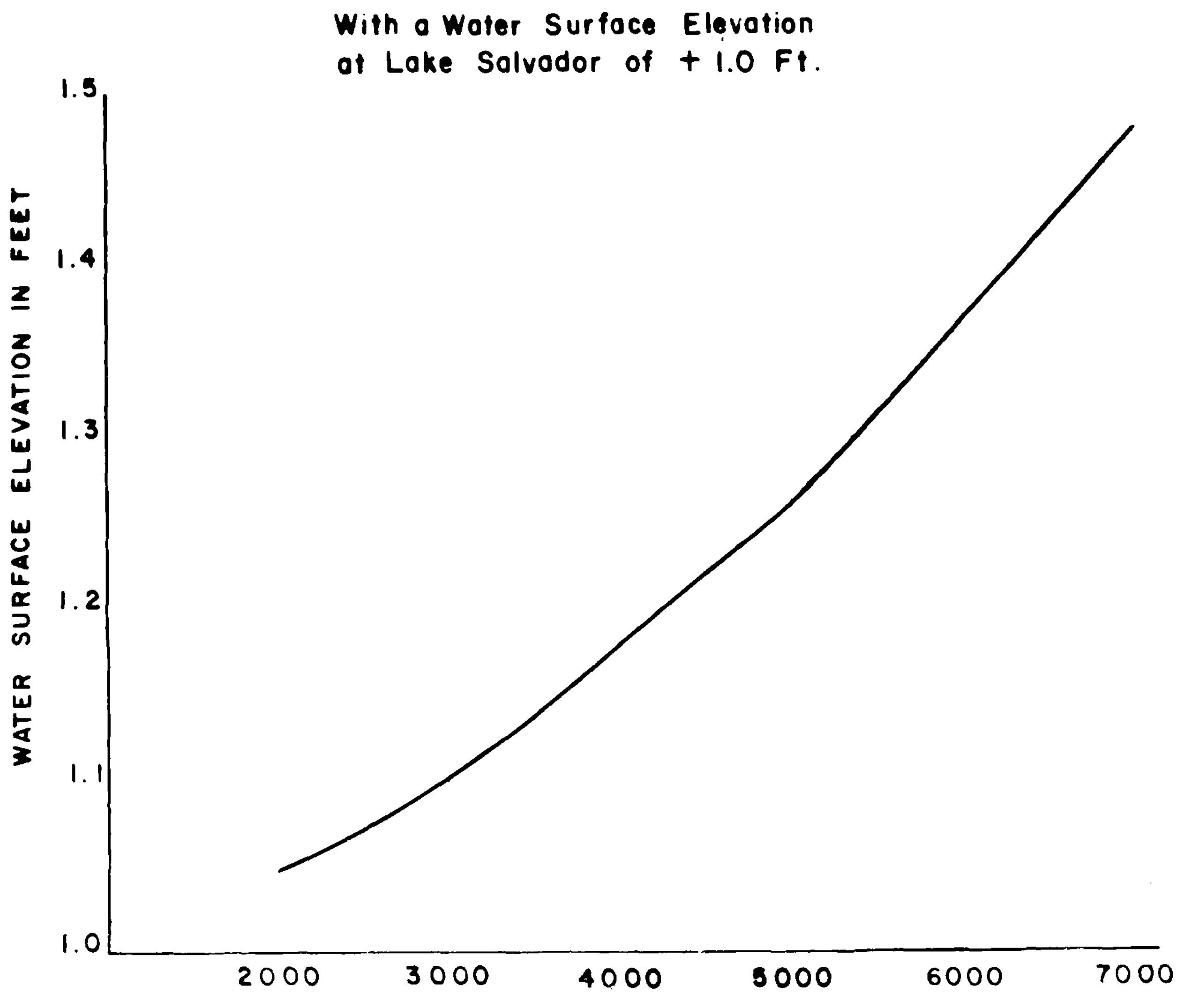
WITH PROJECT
SALINITY LEVELS
FORD LINE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS



Laplace
Reserve
NEW ORLEANS
LAKE BORGNE
Thibodaux
Raceland
Houma
Larose
Golden Meadow
Leeville
Myrtle Grove
Pointe a la Hache
Port Sulphur
Buras
Venice
Caernarvon
Yscloskey
Hopedale
Head of Passes
Breton
MISSISSIPPI
RIVER
BRETON SOUND
BARATARIA BAY
GULF OF MEXICO
LEGEND
PART PER THOUSAND
PLANS 1-5
PLANS 6-10
PLANS 11-5
FORD LINE
5
15
NOTE The Breton Sound Diversion is an element of all plans and Isohalines remain the same for all plans
LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION
PREDICTED 2030 ISOHALINES FOR
10% DROUGHT CONDITION WITH PROJECT
H-2 29437

PLATE C-14



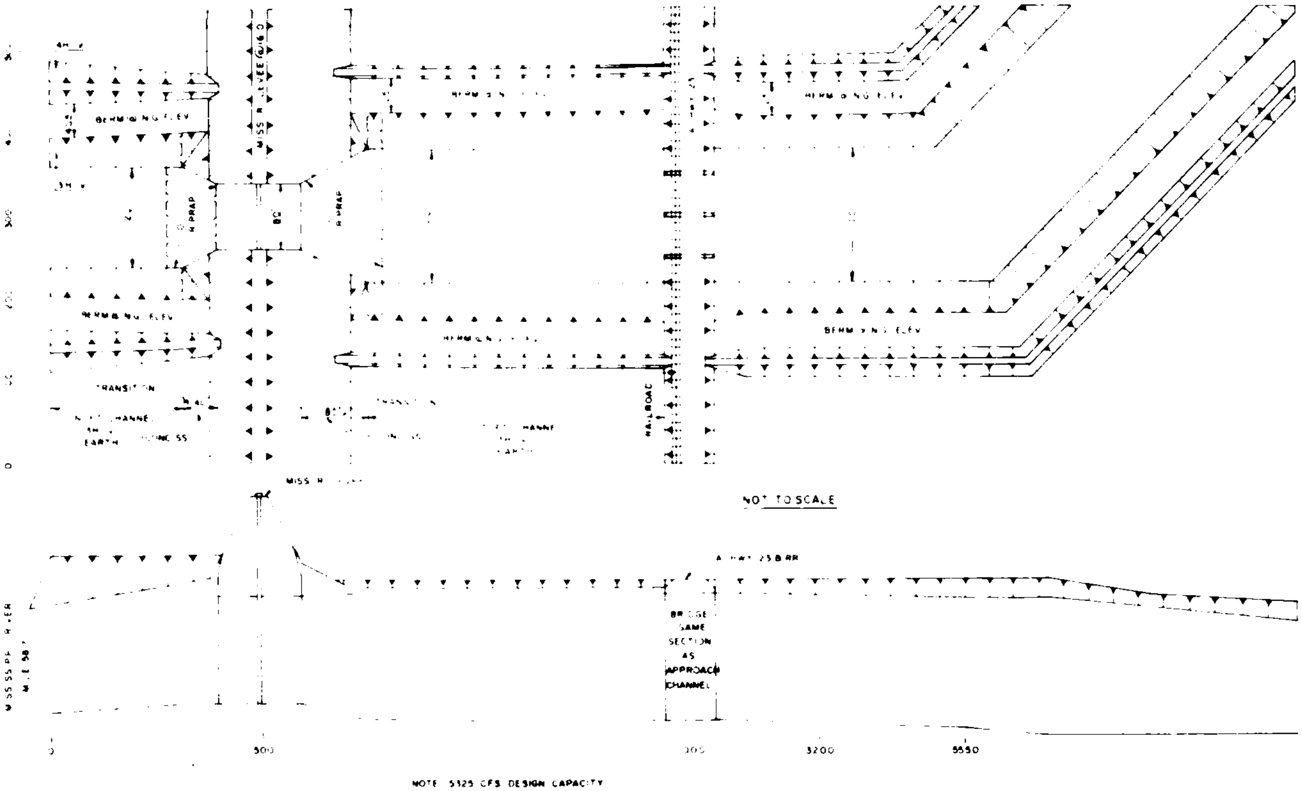
LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

BAYOU BARDEAUX
RATING CURVE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA
CORPS OF ENGINEERS
FILE NO

PLATE C-15

PLATE C-15



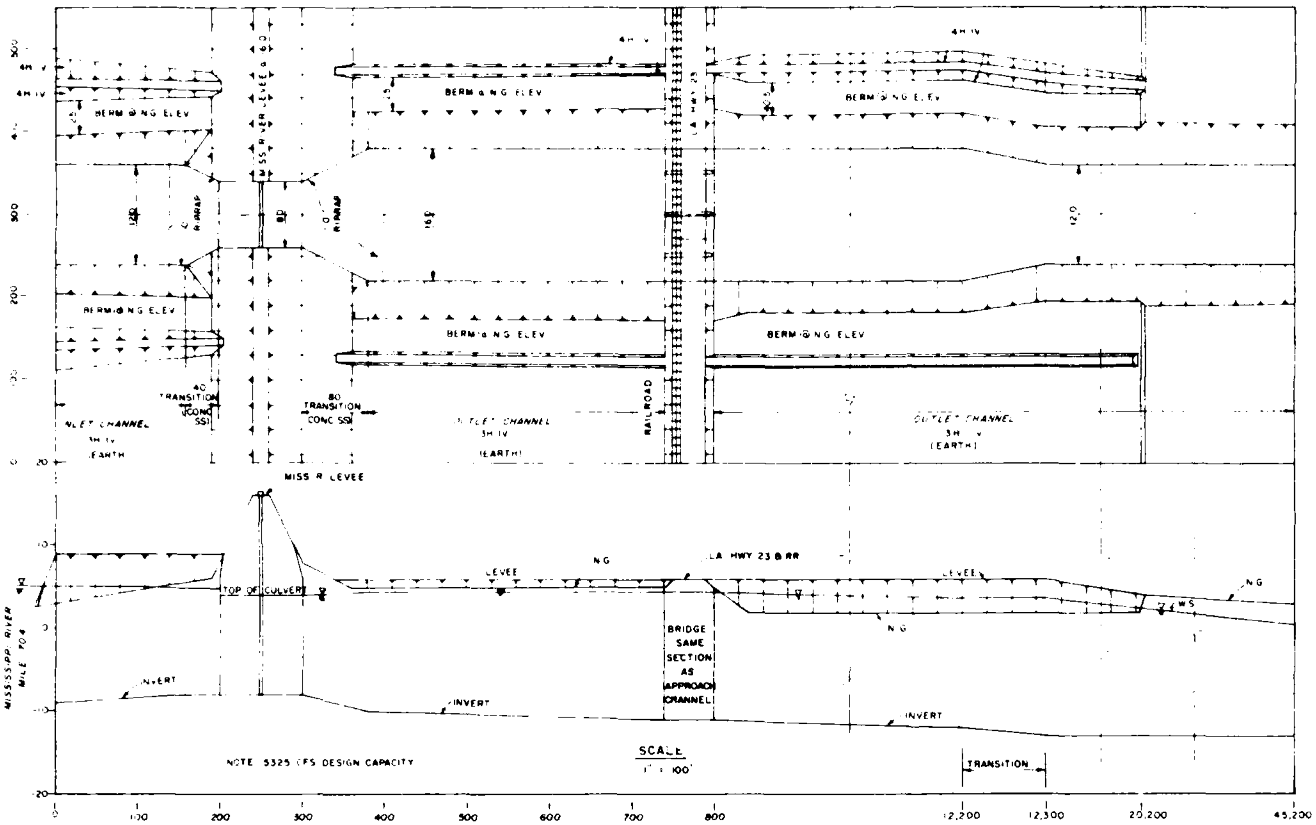
LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

MISS. R. DIVERSION STRUCTURE AND CHANNELS, MYRTLE GROVE MILE 58.7-AHP

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

APRIL 1982 FILE NO. H-2-29437

PLATE 02



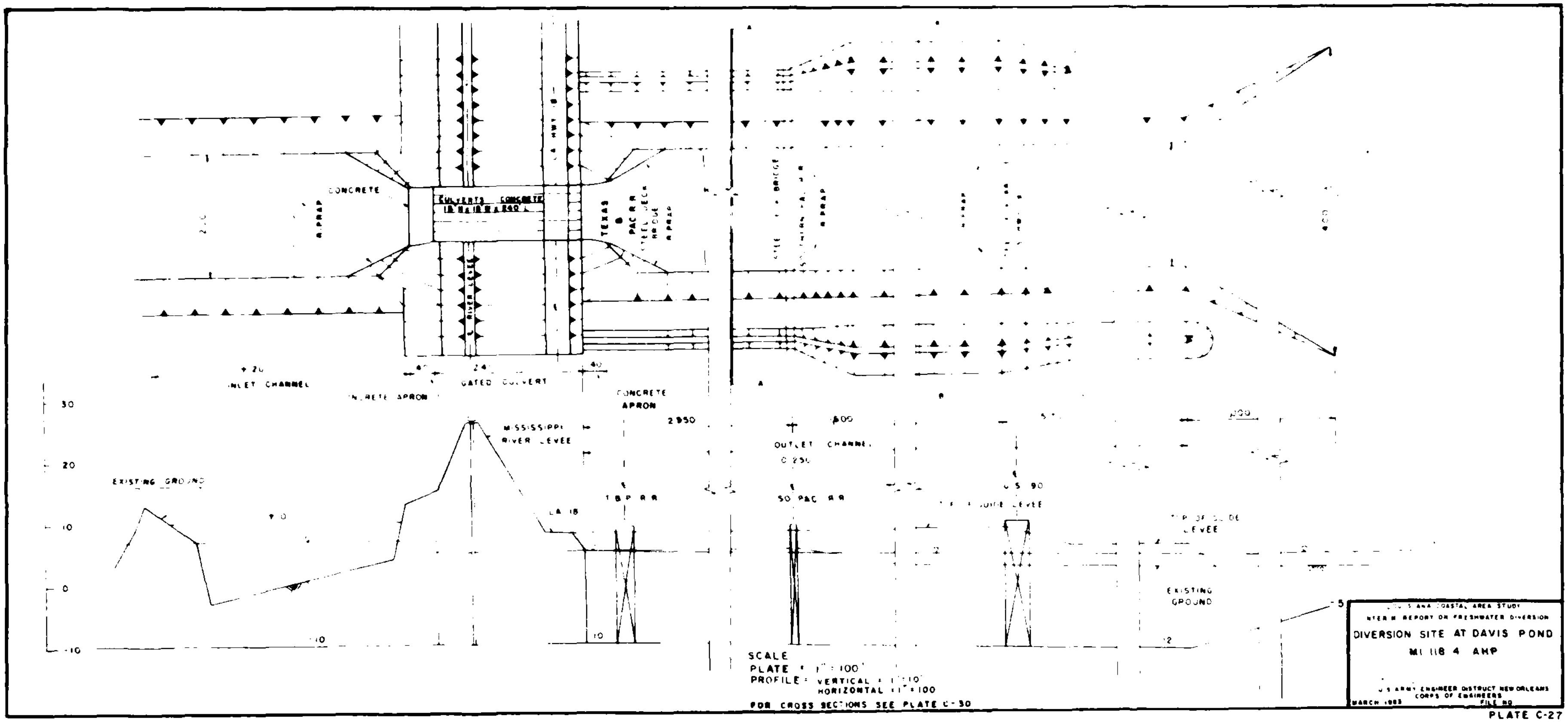
LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

MISS. R DIVERSION STRUCTURE AND CHANNELS, OAKVILLE MILE 70.4-AHP

U S ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

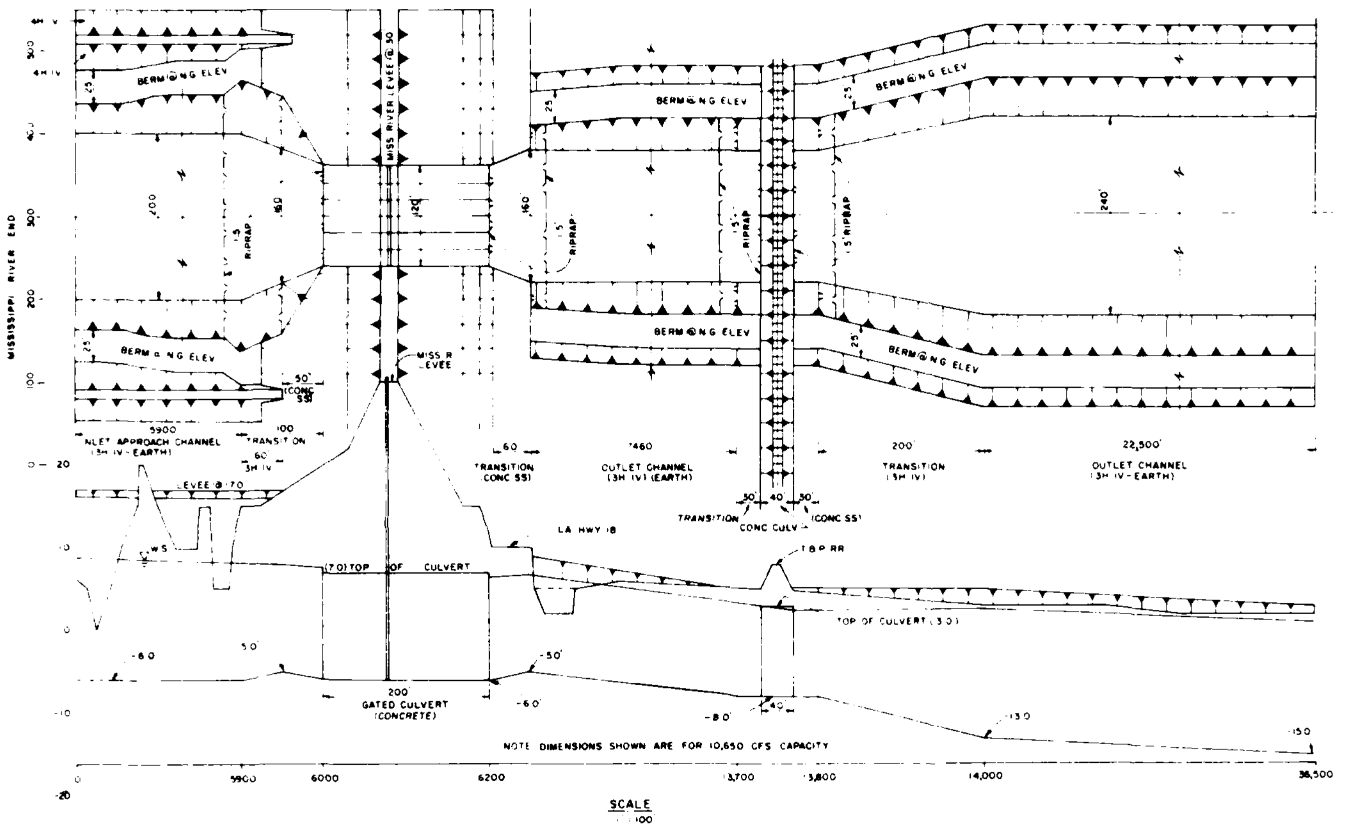
APRIL 1982 | FILE NO. H-2-29437

PLATE C-28



CONCRETE
R.PRAP
CULVERTS CONCRETE
TEXAS & PAC R.R.
STEEL DECK BRIDGE
R.PRAP
INLET CHANNEL
GATED CULVERT
CONCRETE APRON
2950
MISSISSIPPI RIVER LEVEE
EXISTING GROUND
LA 18
T.&P. R.R.
OUTLET CHANNEL
SO PAC R.R.
U.S. 90
EXISTING GROUND
30
20
10
0
-10
SCALE
PLATE
PROFILE: VERTICAL
HORIZONTAL
FOR CROSS SECTIONS SEE PLATE C-30
DIVERSION SITE AT DAVIS POND
MI 118.4 AHP
U.S. ARMY ENGINEER DISTRICT NEW ORLEANS
CORPS OF ENGINEERS
FILE NO

PLATE C-27



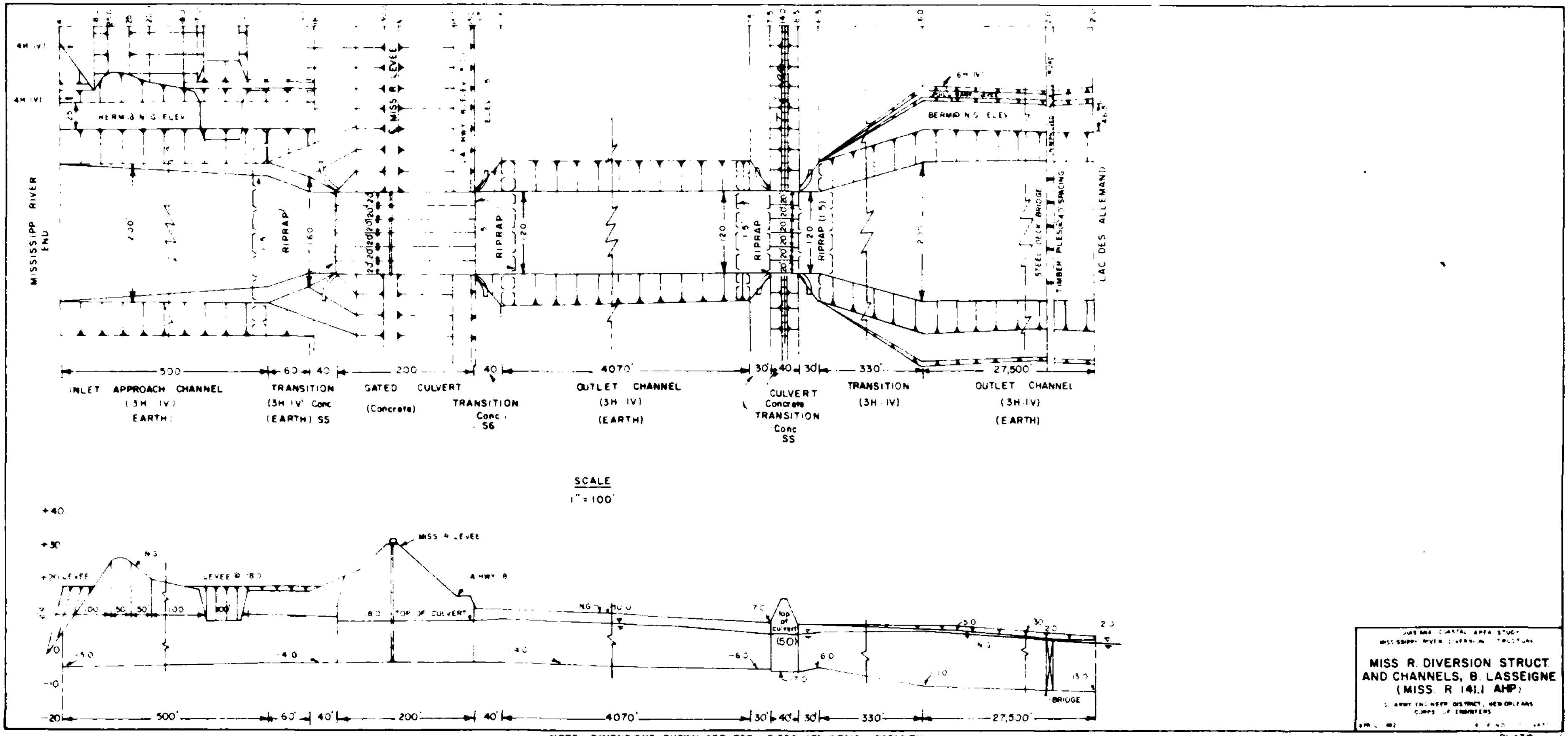
LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

MISS. R. DIVERSION STRUCTURE AND CHANNELS, BAYOU FORTIER MILE 132.0-AHP

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

APRIL 1982 FILE NO. H-2-2945

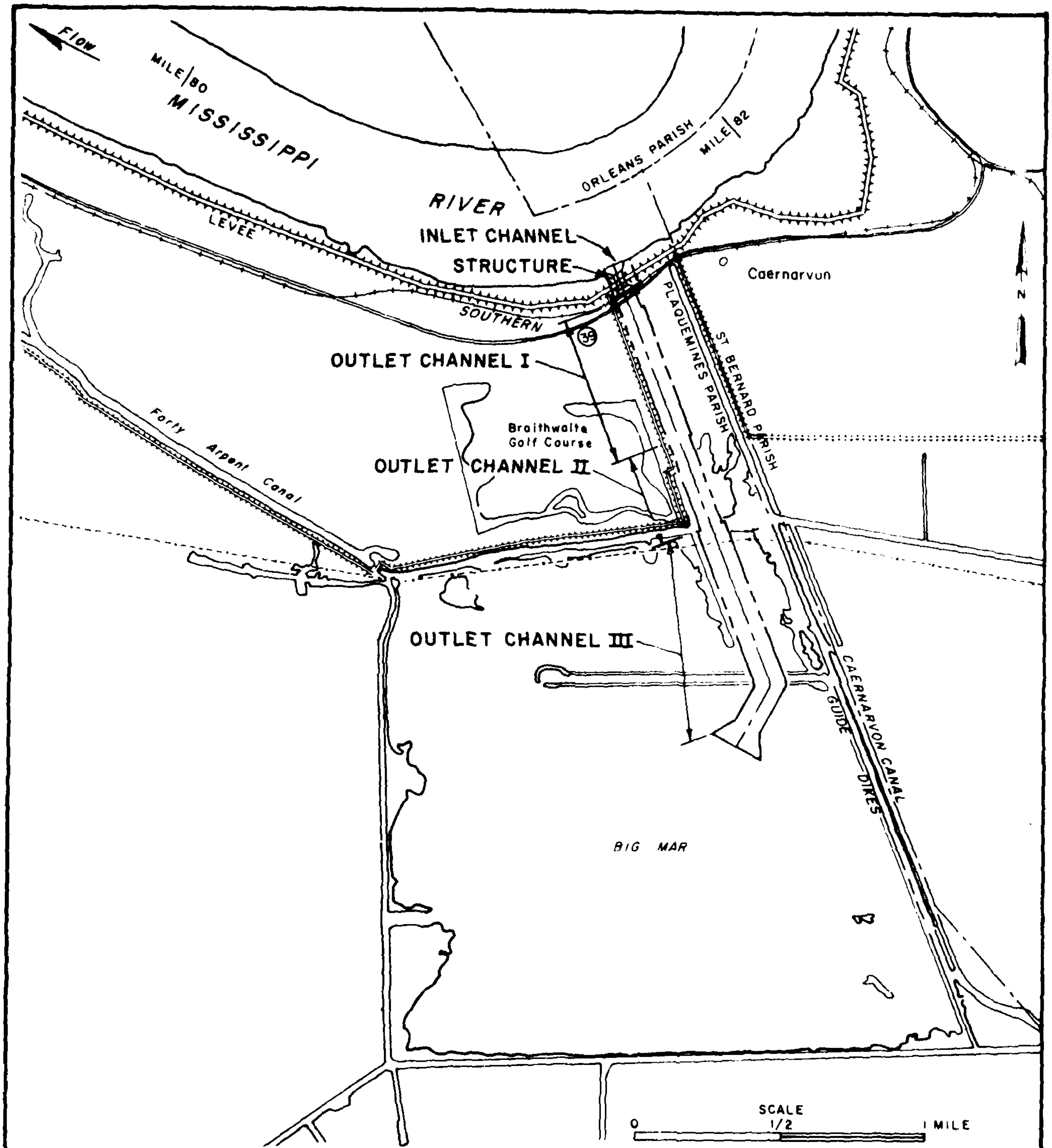
PLATE C-[illegible]



NOTE DIMENSIONS SHOWN ARE FOR 10,650 CFS DESIGN CAPACITY

MISS R. DIVERSION STRUCT AND CHANNELS, B. LASSEIGNE (MISS. R 141.1 AHP)

PLATE



RIGHTS OF WAY, WIDTH AND LENGTH

ITEM	LENGTH (ft)	MAXIMUM DESIGN FLOW (cfs) 6600	4400 WIDTH (ft)	2200
INLET CHANNEL	800	449	347	295
OUTLET CHANNEL I	2550	415 5	317	247
OUTLET CHANNEL II	1750	342	263	258
OUTLET CHANNEL III	3800	460	344	258

LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

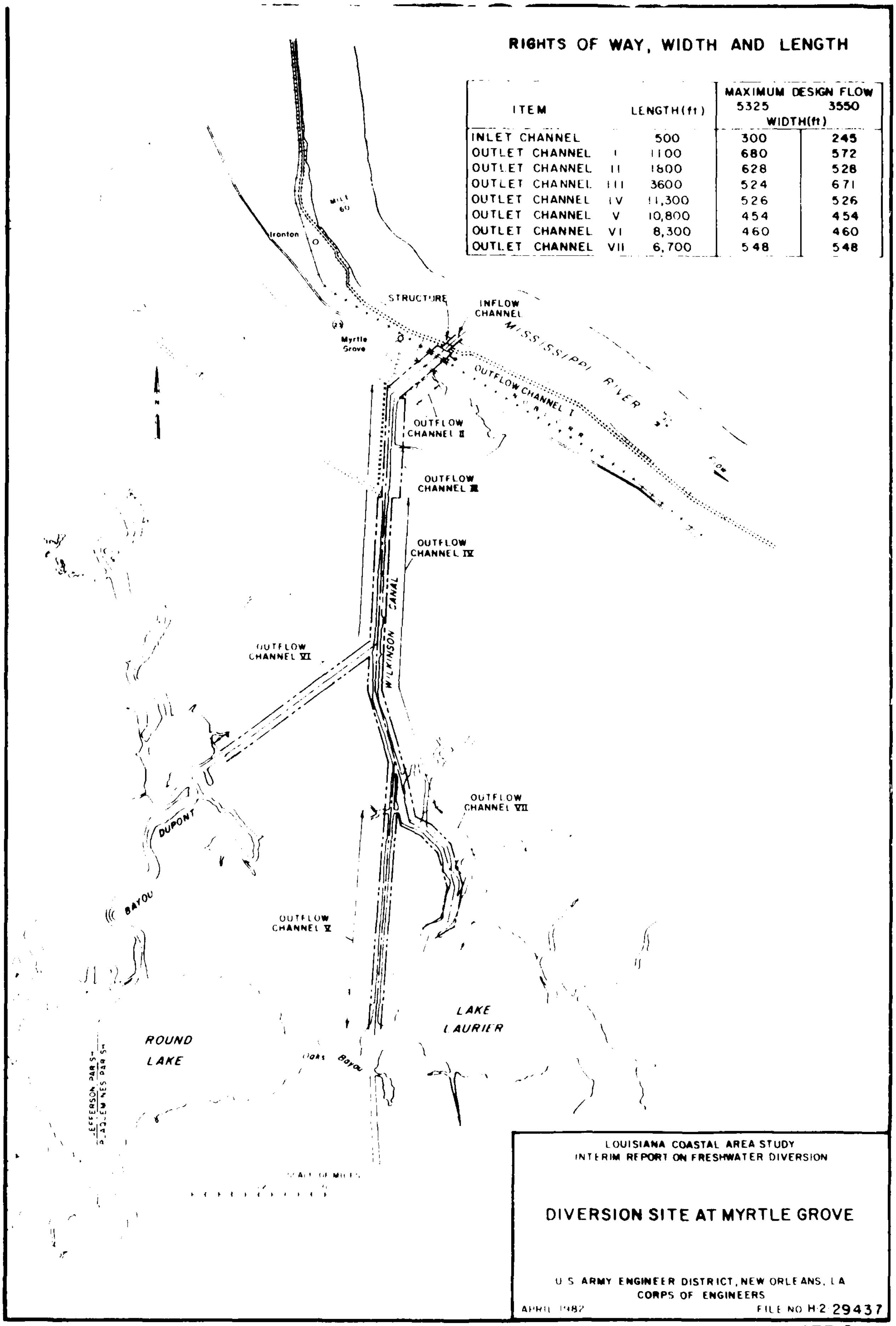
DIVERSION SITE NEAR CAERNARVON

U S ARMY ENGINEER DISTRICT, NEW ORLEANS, LA
CORPS OF ENGINEERS

APRIL 1982 FILE NO H 2-29437

RIGHTS OF WAY, WIDTH AND LENGTH

ITEM		LENGTH (ft)	MAXIMUM DESIGN FLOW 5325 WIDTH (ft)	MAXIMUM DESIGN FLOW 3550 WIDTH (ft)
INLET CHANNEL		500	300	245
OUTLET CHANNEL	I	1100	680	572
OUTLET CHANNEL	II	1800	628	528
OUTLET CHANNEL	III	3600	524	671
OUTLET CHANNEL	IV	11,300	526	526
OUTLET CHANNEL	V	10,800	454	454
OUTLET CHANNEL	VI	8,300	460	460
OUTLET CHANNEL	VII	6,700	548	548



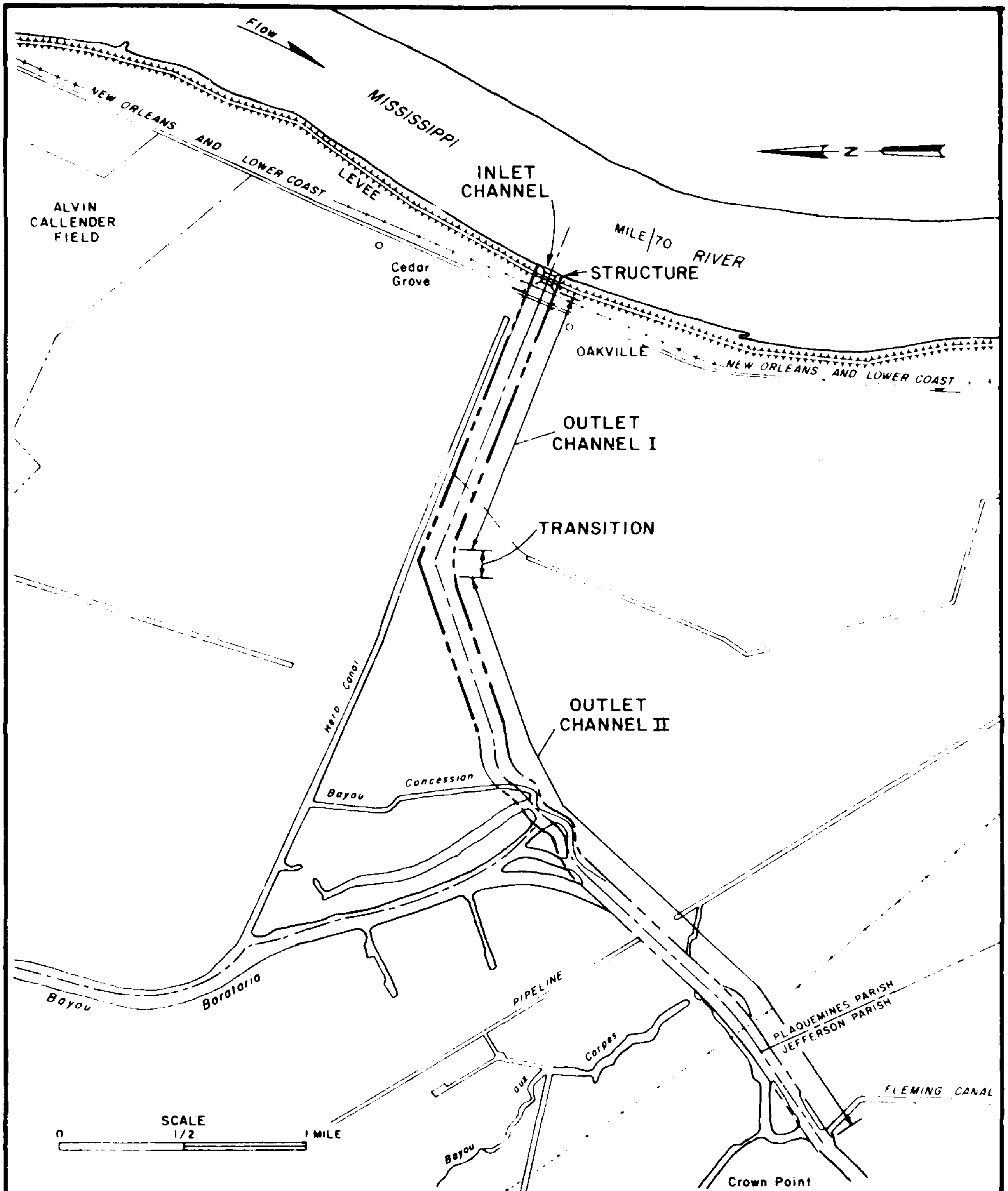
LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

DIVERSION SITE AT MYRTLE GROVE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA
CORPS OF ENGINEERS

APRIL 1982 FILE NO. H-2 29437

PLATE C-23



RIGHTS OF WAY, WIDTH AND LENGTH

ITEM	LENGTH(ft)	MAXIMUM DESIGN FLOW(cfs) 5325	3550
		WIDTH(ft)	
INLET CHANNEL	160	582	453
STRUCTURE & BRIDGE	420	823-312	566-212
OUTLET CHANNEL I	11,400	731	517
TRANSITION	100	445 TO 405	345-405
OUTLET CHANNEL II	7800	408 TO 384	408-384

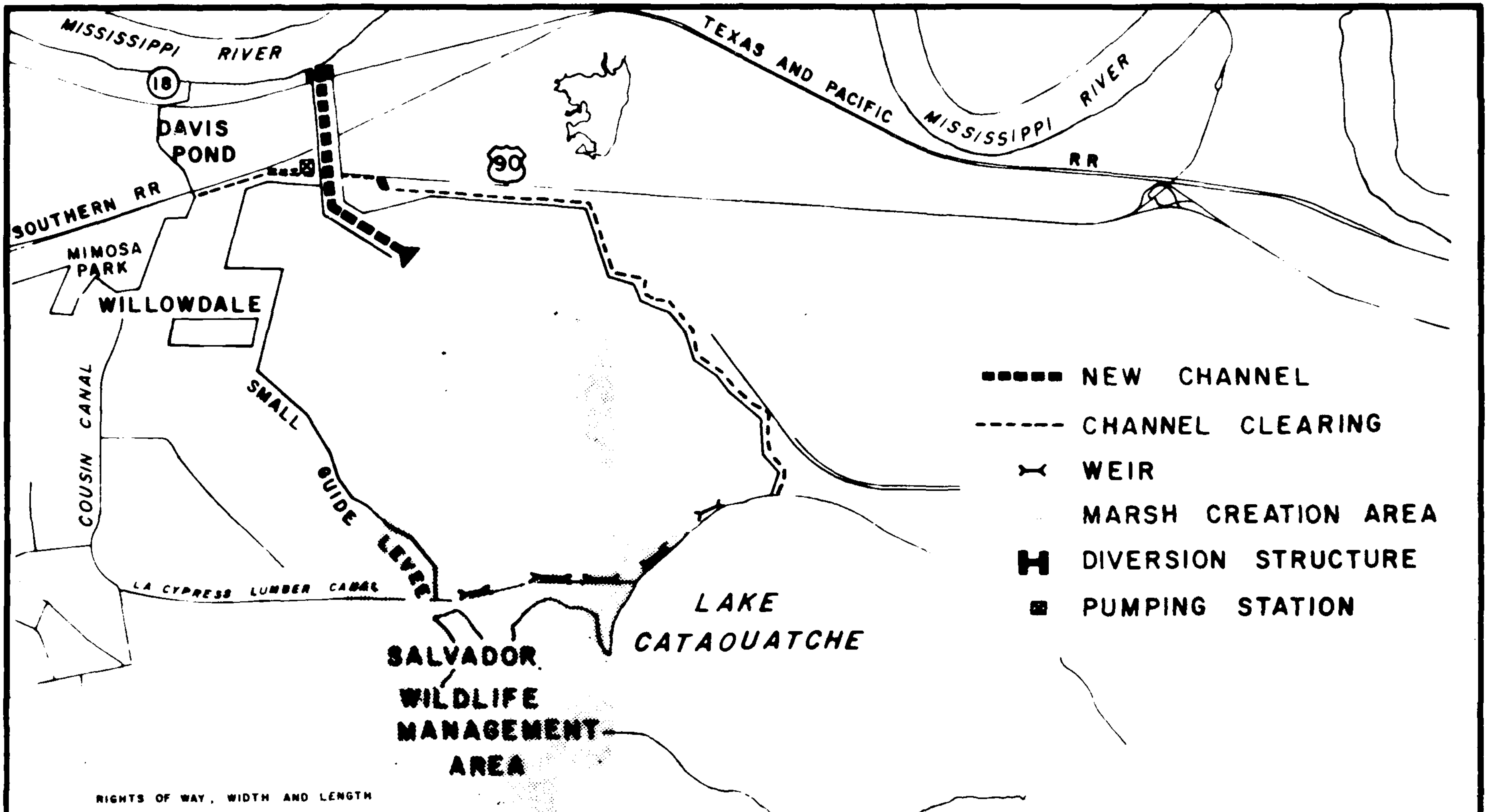
LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

DIVERSION SITE AT OAKVILLE

U S ARMY ENGINEER DISTRICT, NEW ORLEANS, LA
CORPS OF ENGINEERS

APRIL 1982 FILE NO H-2-29437

PLATE C-22



RIGHTS OF WAY, WIDTH AND LENGTH

ITEM		LENGTH FEET	MAXIUM DISIGN FLOW (FEET) 10,650 WIDTH (FEET)
REACH A	INLET CHANNEL	520	480'
REACH A	OUTLET CHANNEL TO SOUTHERN PACIFIC RAILROAD	2,950	480'
	OUTLET CHANNEL TO US HWY 90	1,800	580'
REACH B	OUTLET CHANNEL TO IMPOUNDMENT	5,700	530'
	WEST GUIDE LEVEE	36,960	100'
	EAST GUIDE LEVEE	26,400	150'

LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

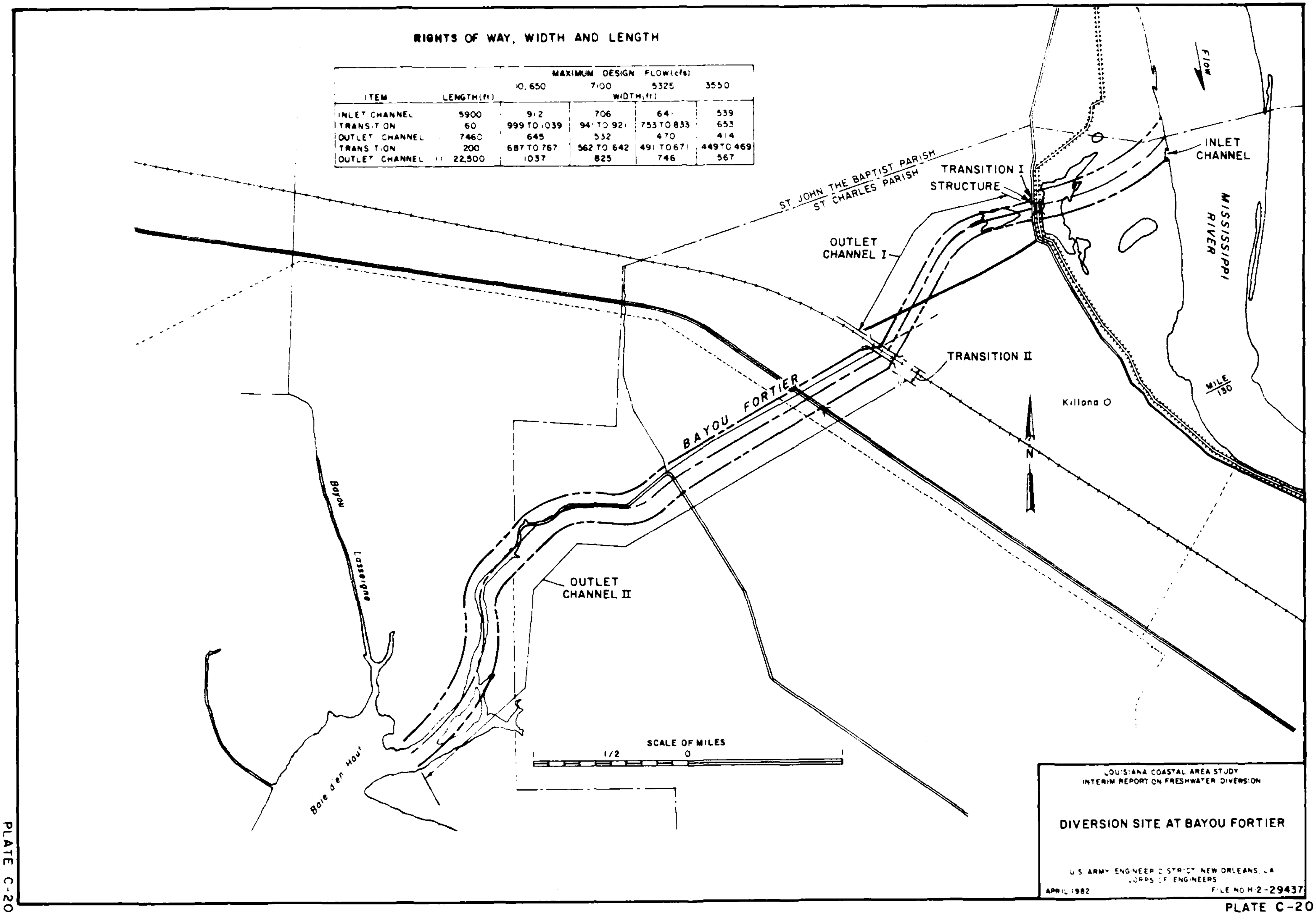
DIVERSION SITE, DAVIS POND
MI. 118.4 AHP

U S ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
MARCH 1983 FILE NO.

PLATE C - 21

RIGHTS OF WAY, WIDTH AND LENGTH

ITEM	LENGTH (ft)	MAXIMUM DESIGN FLOW (cfs) 10,650	7100	5325	3550
		WIDTH (ft)			
INLET CHANNEL	5900	912	706	641	539
TRANSITION	60	999 TO 1039	941 TO 921	753 TO 833	653
OUTLET CHANNEL	7460	645	532	470	414
TRANSITION	200	687 TO 767	562 TO 642	491 TO 671	449 TO 469
OUTLET CHANNEL II	22,500	1037	825	746	567



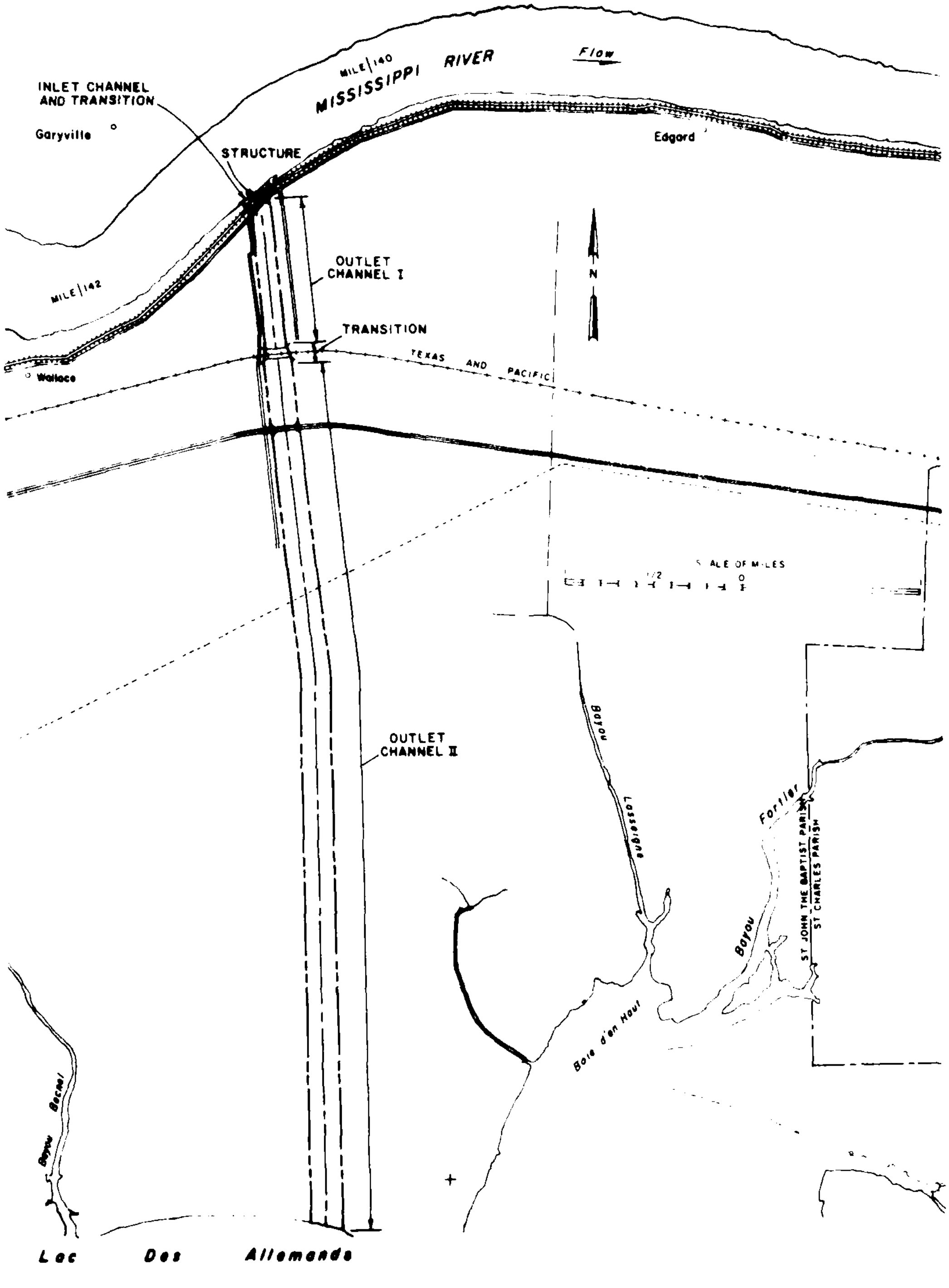
LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

DIVERSION SITE AT BAYOU FORTIER

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA
CORPS OF ENGINEERS

APRIL 1982 FILE NO. H-2-29437

PLATE C-20



RIGHTS OF WAY, WIDTH AND LENGTH

ITEM	LENGTH(ft.)	MAXIMUM DESIGN FLOW(cfs) 10,650	7100	5325	3550
		WIDTH(ft)			
INLET CHANNEL	500	1041	805	719	605
TRANSITION	60	943-903	739-719	683-663	589
OUTLET CHANNEL I	4250	682	546	488	433
TRANSITION	330	691-771	606-666	547-587	460- 500
OUTLET CHANNEL	27,800	896	776	665	532

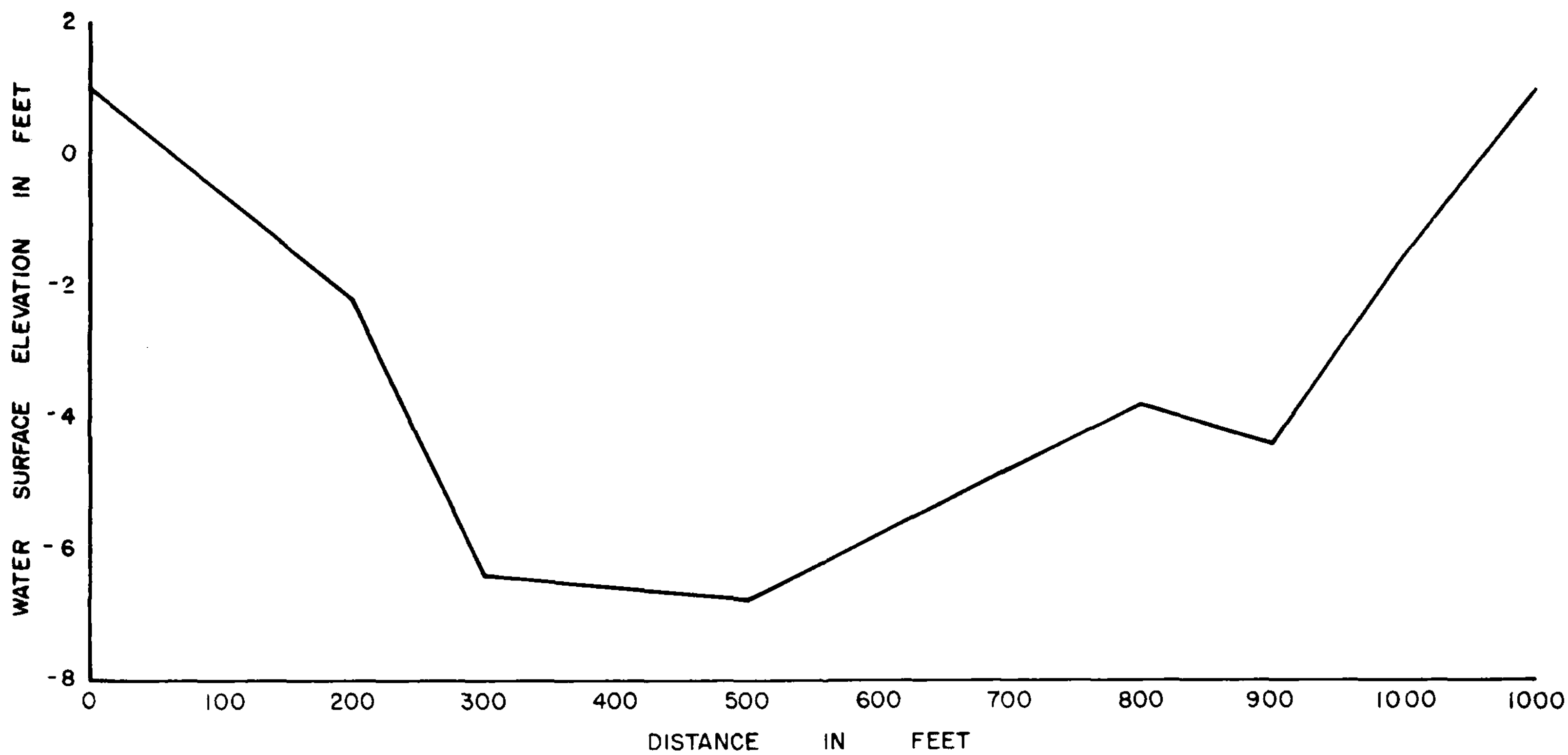
LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

DIVERSION SITE NEAR BAYOU LASSEIGNE

U S ARMY ENGINEER DISTRICT, NEW ORLEANS, LA
CORPS OF ENGINEERS

APRIL 1982 FILE NO. H-2-29437

PLATE C-19



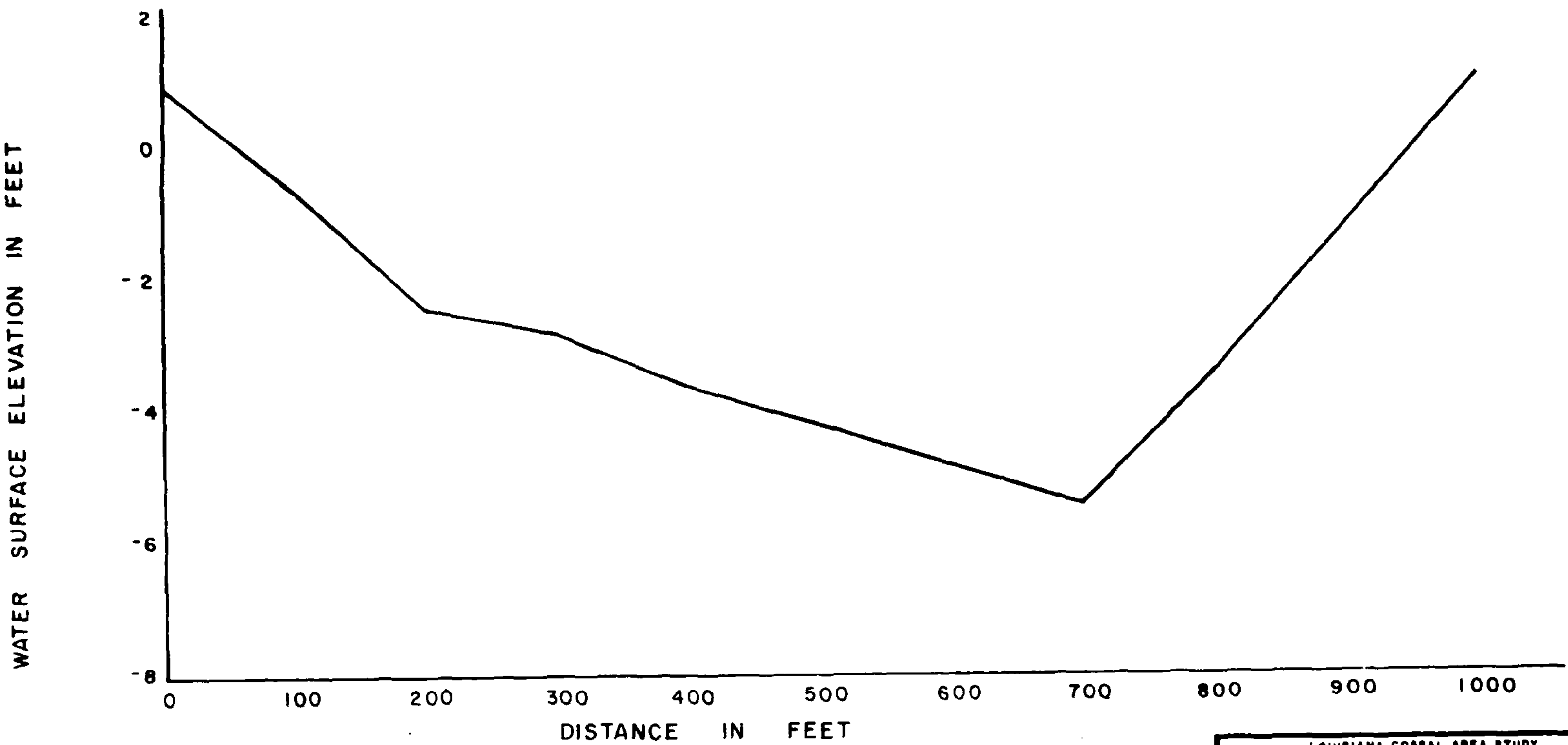
LOUISIANA COASAL AREA STUDY
INTERIM REPORT ON FRESHWAY DIVERSION

BAYOU COUBA
CHANNEL CROSS-SECTIONS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA
CORPS OF ENGINEERS
FILE NO.

PLATE C-18

PLATE C-18



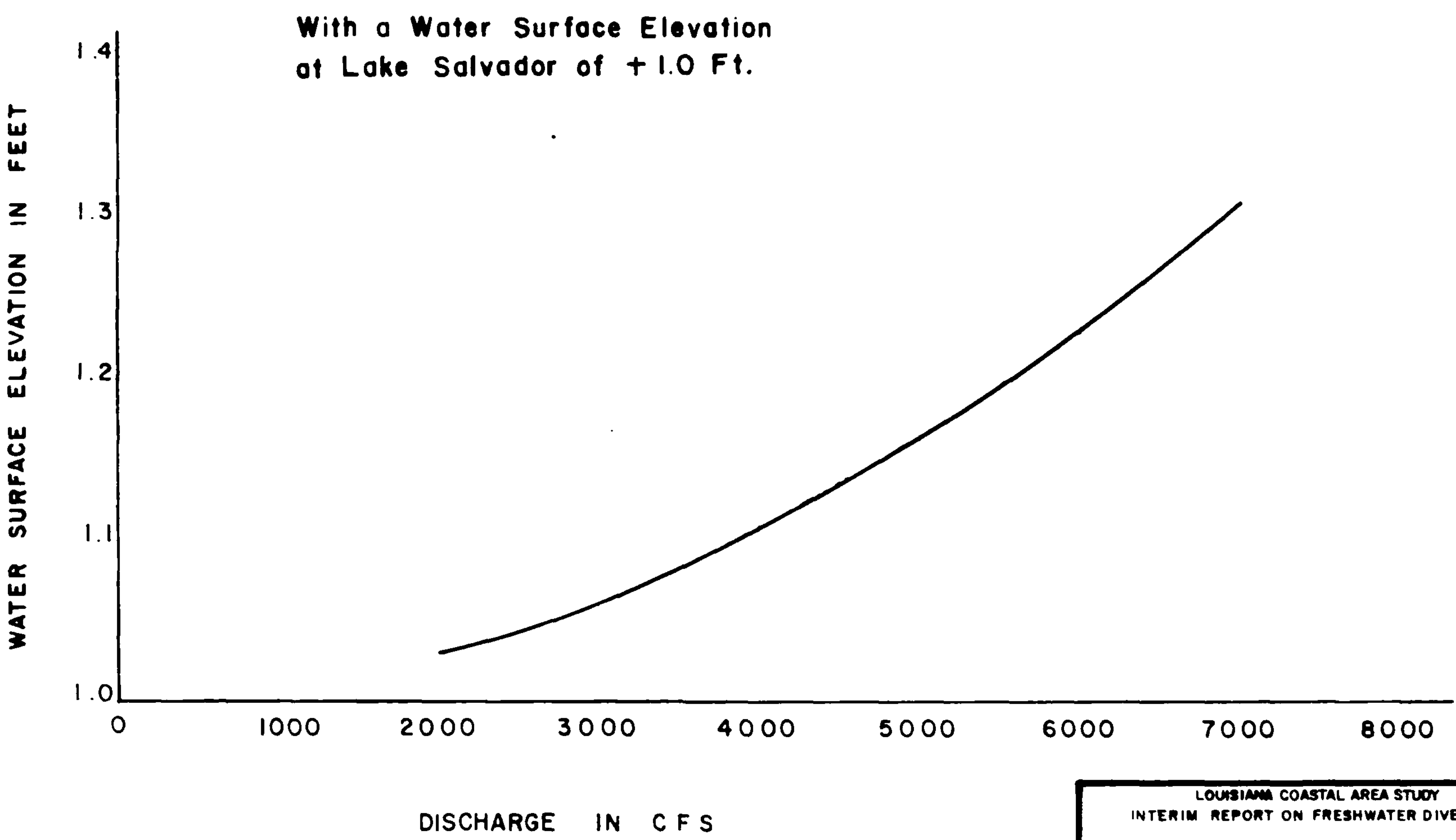
LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWAY DIVERSION

BAYOU BARDEAUX
CHANNEL CROSS-SECTIONS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA
CORPS OF ENGINEERS
FILE NO

PLATE C-17

PLATE C-17

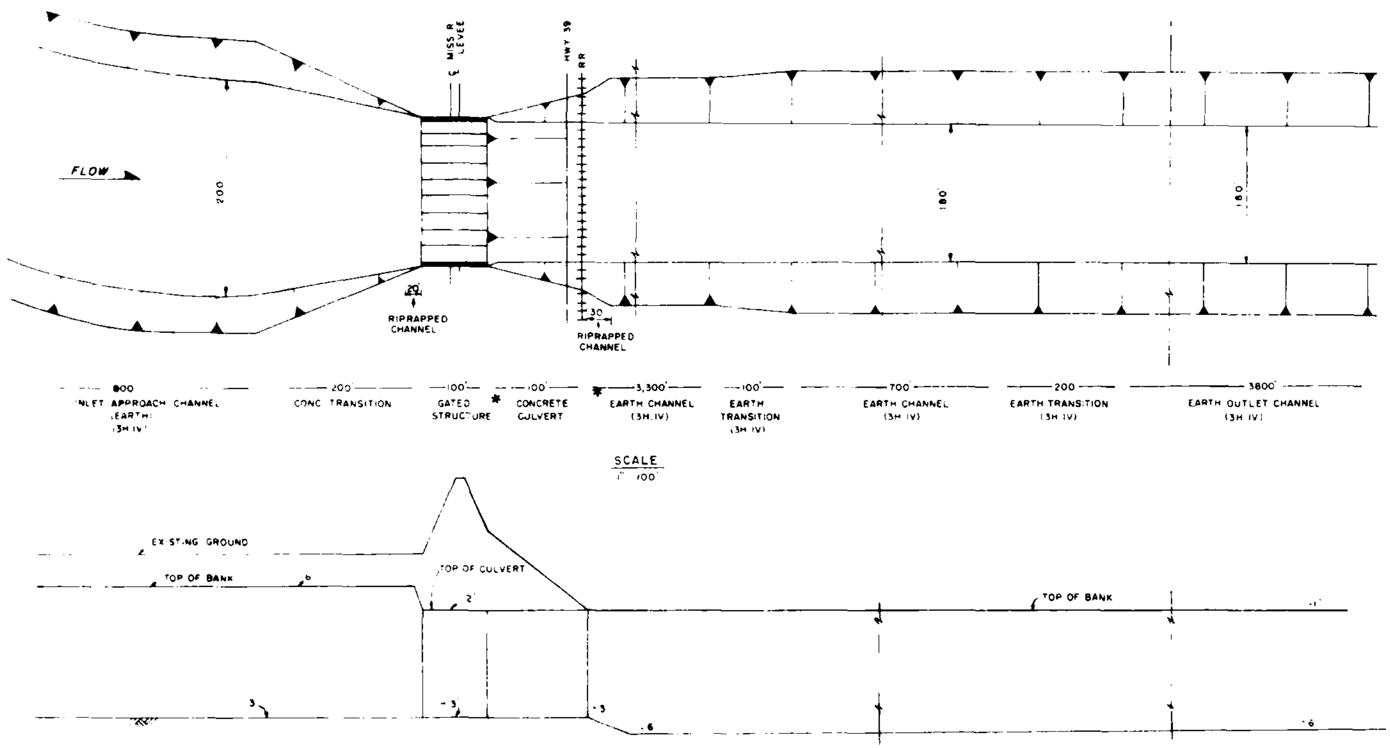


LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

BAYOU COUBA
RATING CURVE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS LA.
CORPS OF ENGINEERS

PLATE C-16



LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

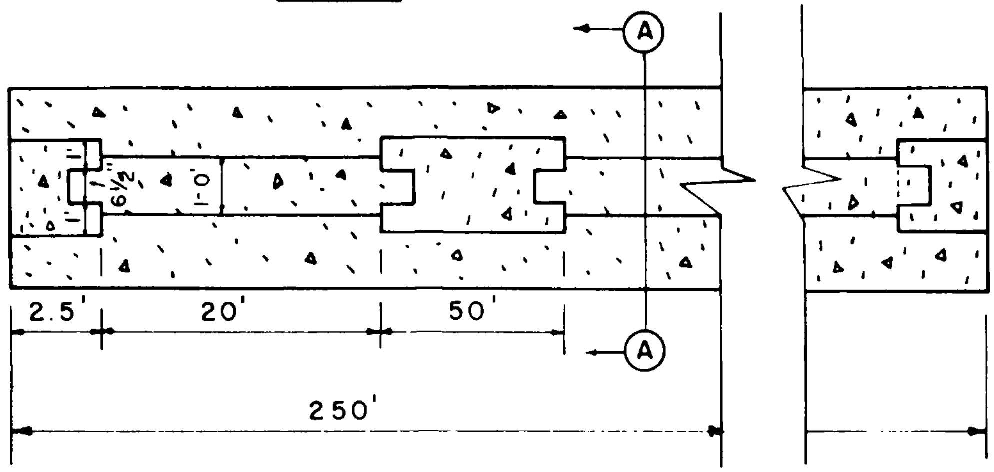
MISS R DIVERSION STRUCTURE AND CHANNELS, NEAR CAERNARVON MILE 81.5 AHP

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

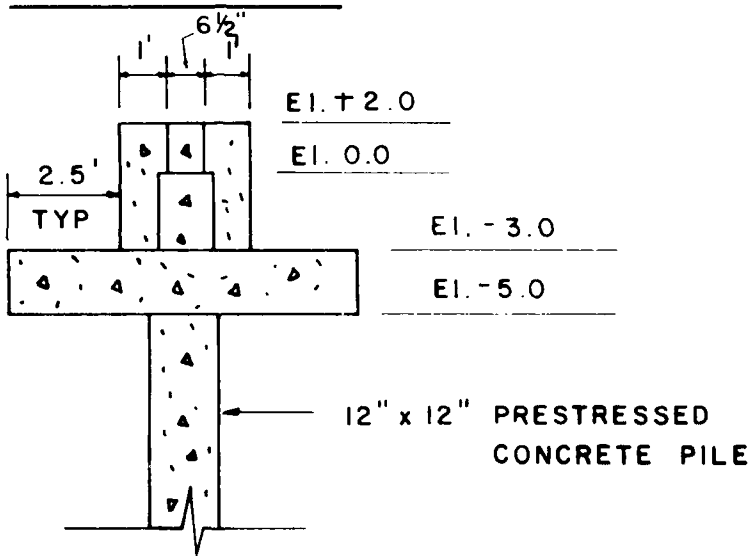
APRIL 198[illegible] FILE NO H-2-29437

PLATE C-[illegible]

PLAN



SECTION A - A

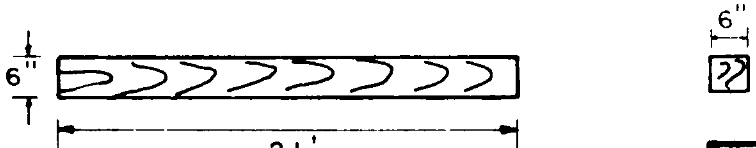


SECTION A A

NOT TO SCALE

STOPLOGS

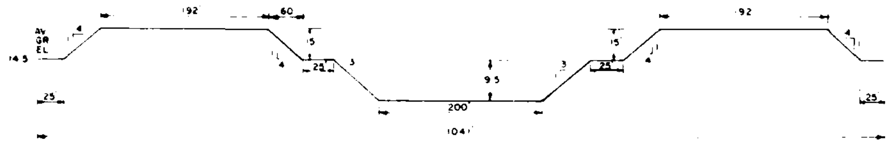
APPROX. WT.
200 lbs.



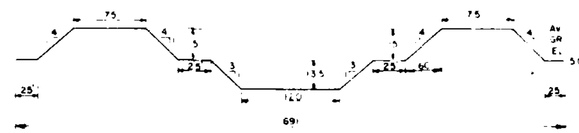
LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

TIMBER STOP LOG WEIRS AT LOWER END OF DAVIS POND IMPOUNDMENT

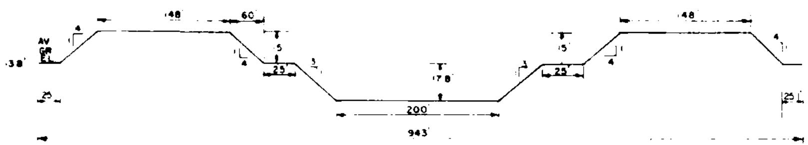
U S ARMY ENGINEER DISTRICT NEW ORLEANS
CORPS OF ENGINEERS
MARCH 1983 FILE NO.



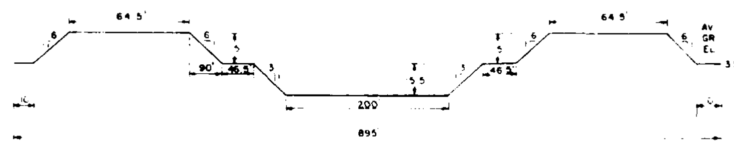
INLET CHANNEL - DISTANCE = 500'



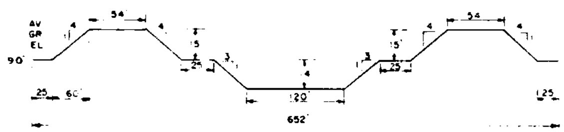
TRANSITION II - DISTANCE = 330'



TRANSITION I - DISTANCE = 60'



OUTLET CHANNEL II DISTANCE = 27,500'



OUTLET CHANNEL I - DISTANCE = 4,250

NOT TO SCALE

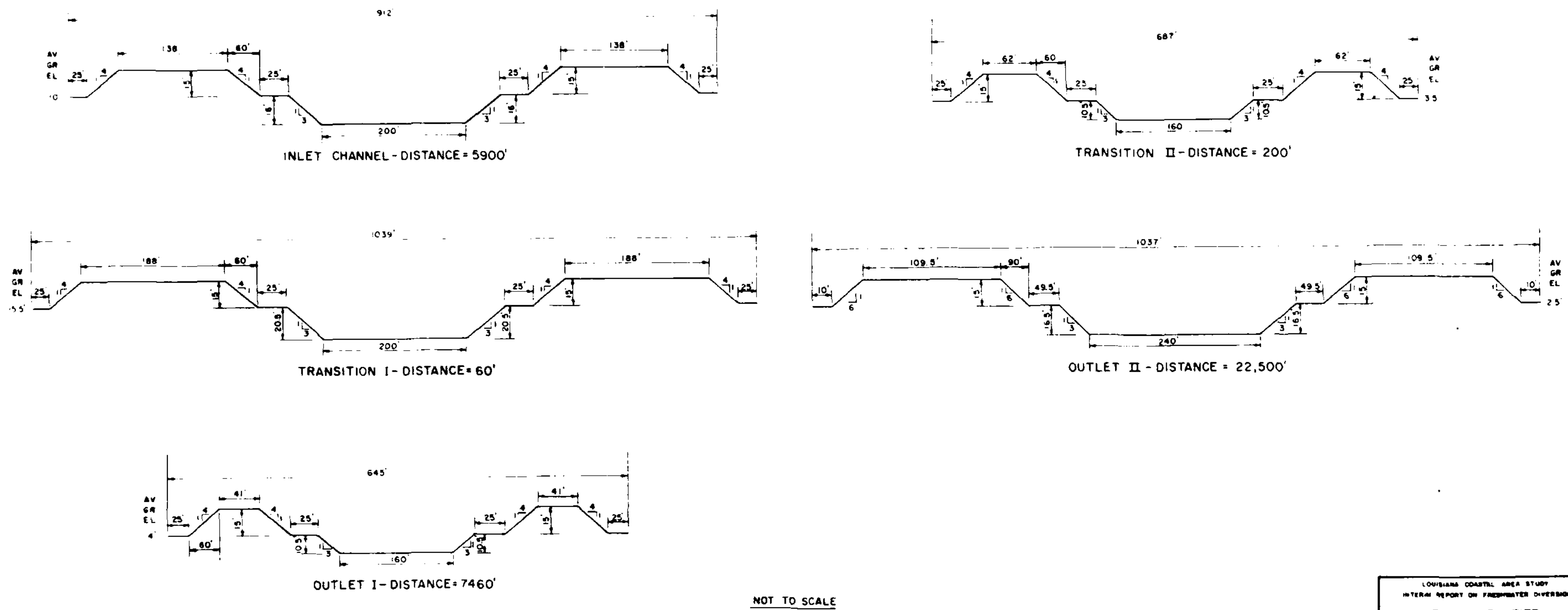
LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

BAYOU LASSEIGNE
TYPICAL SECTIONS
MILE 141.1 A.H.P.

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

APRIL 1982 FILE [illegible]

PLATE C-[illegible]



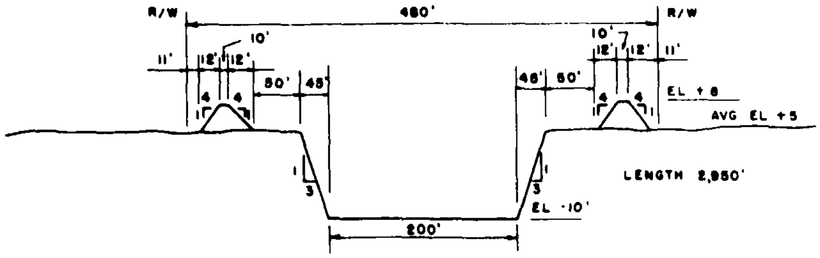
LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

BAYOU FORTIER
TYPICAL SECTIONS
MILE 132.0 AHP

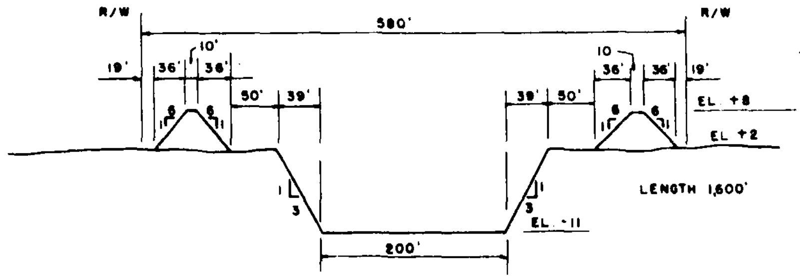
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

APRIL 1982 FILE NO. H-2-29437

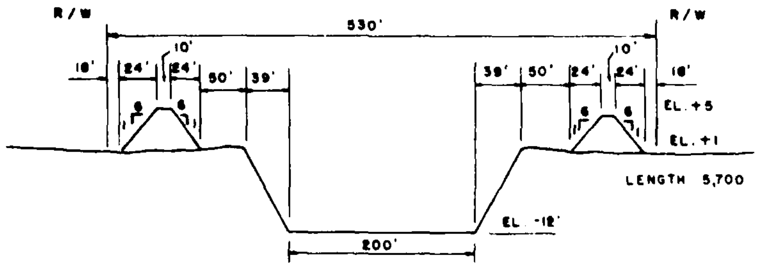
PLATE C-26



SECTION A-A



SECTION B-B



SECTION C-C

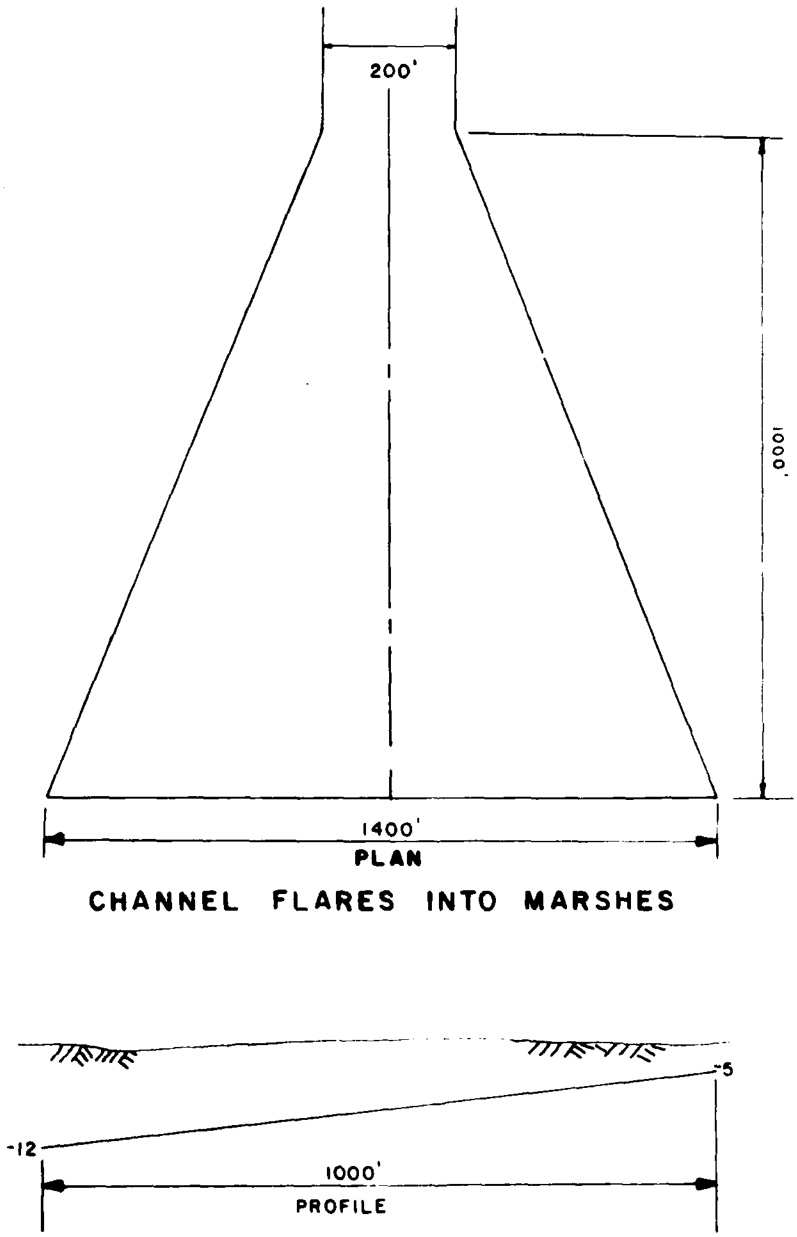
LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

DAVIS POND TYPICAL SECTIONS

MI. 118.4 AHP

DIVERSION CHANNEL

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
MARCH 1983 FILE NO.



LOUISIANA COASTAL AREA STUDY

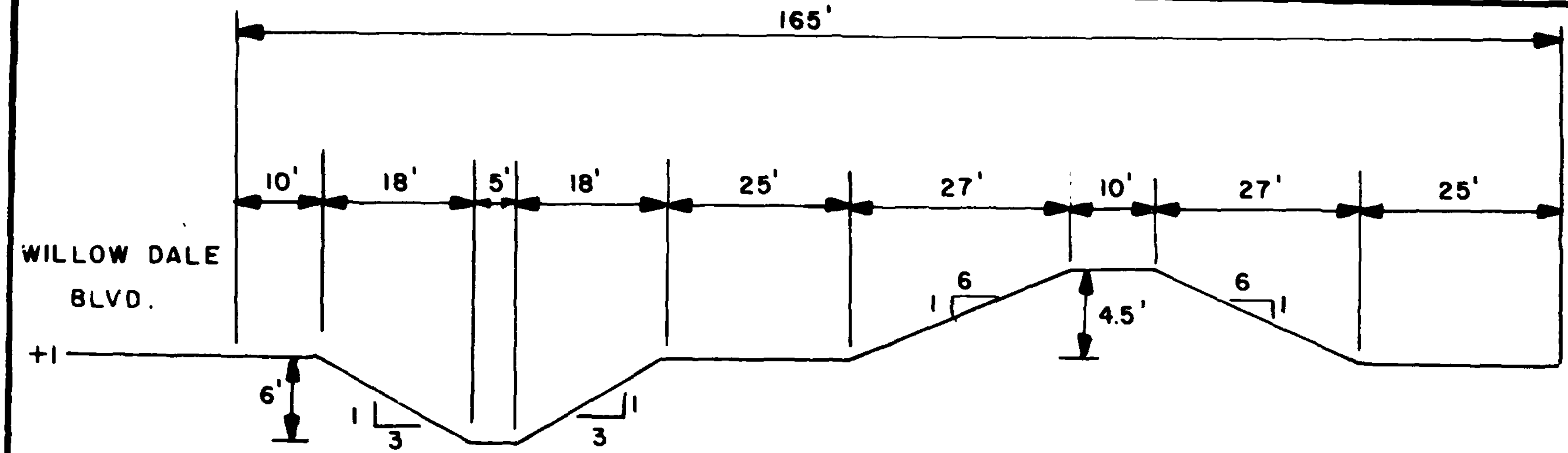
INTERIM REPORT ON FRESHWATER DIVERSION

DAVIS POND TYPICAL SECTION

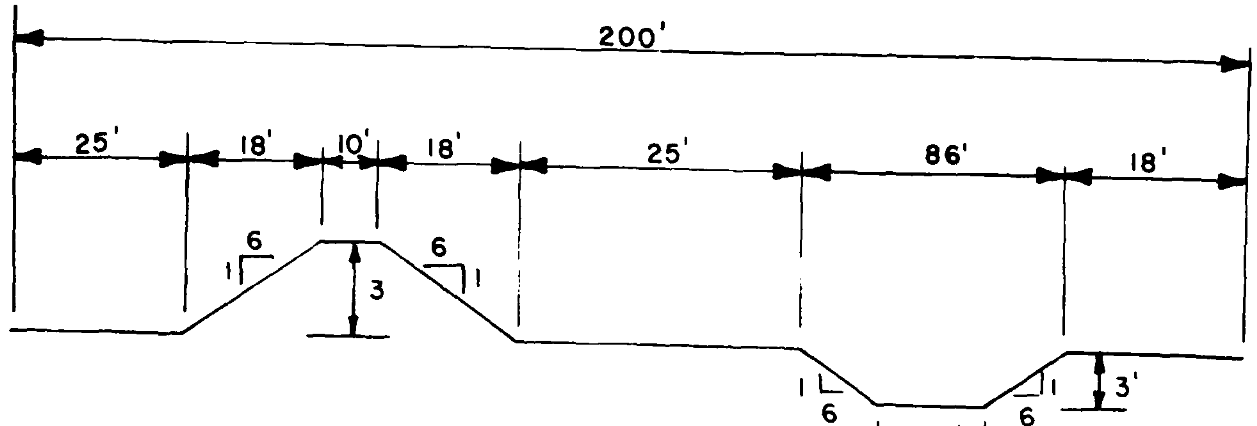
MI. 118.4 AHP

U.S. ARMY ENGINEER DISTRICT NEW ORLEANS
CORPS OF ENGINEERS

MARCH 1983 FILE NO.



WEST GUIDE LEVEE FROM HWY. 90 TO BAYOU CYPRIERE LONGUE



LOWER WEST GUIDE LEVEE ALONG BAYOU CYPRIERE LONGUE

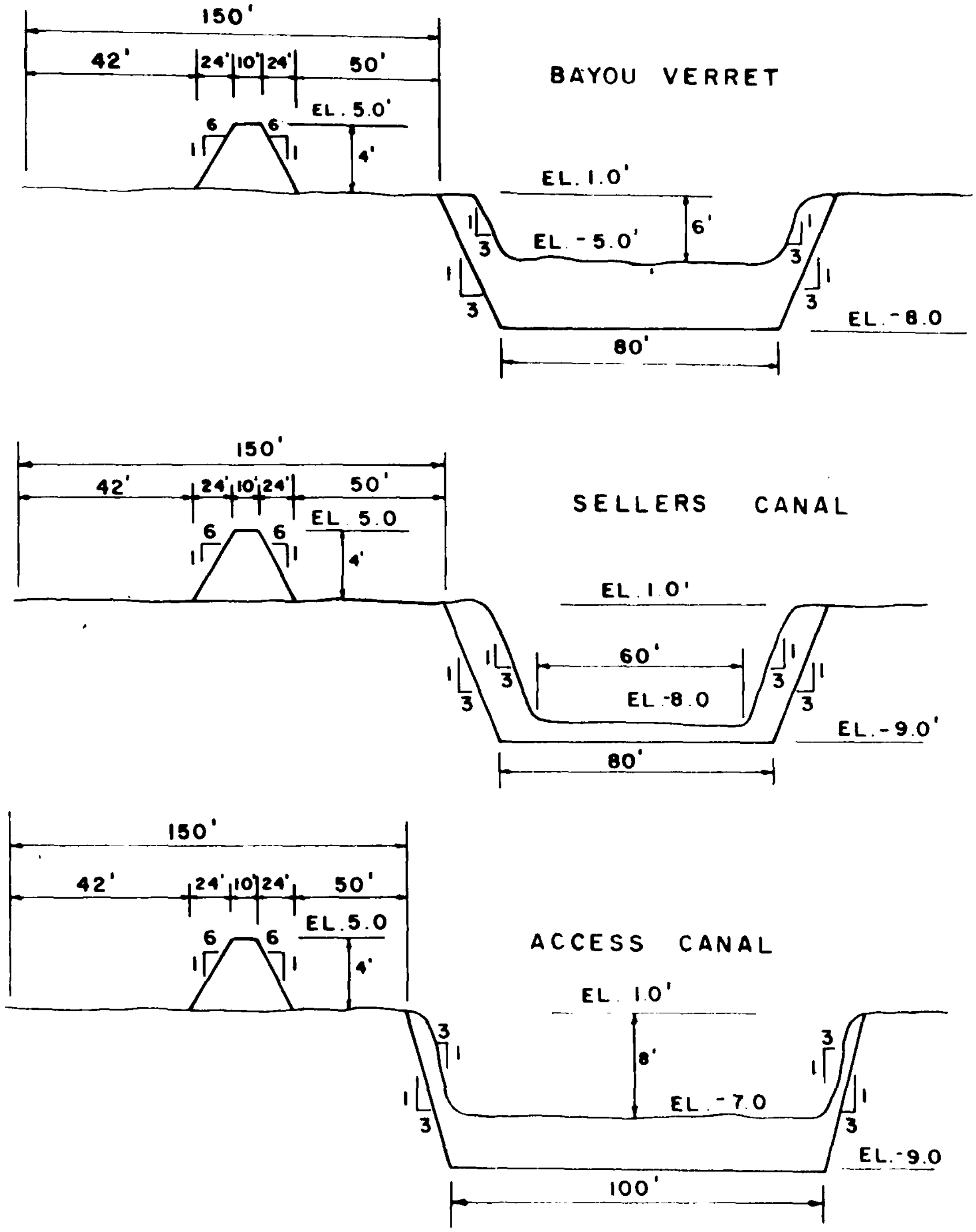
LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

DAVIS POND TYPICAL SECTIONS
MI. 118.4 AHP

WEST GUIDE LEVEE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
MARCH 1983
FILE NO.

PLATE C-36



LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

DAVIS POND TYPICAL SECTIONS Mi. 118.4 AHP

EAST GUIDE LEVEE

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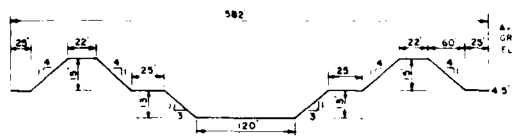
CORPS OF ENGINEERS
MARCH 1983 FILE NO.



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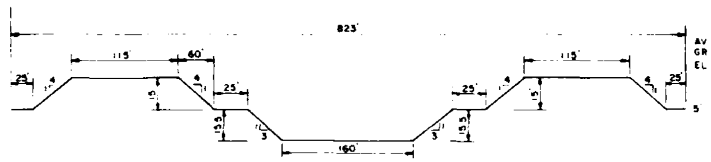

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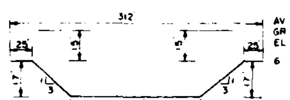

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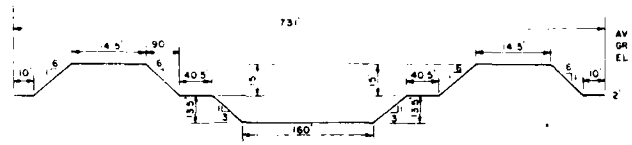

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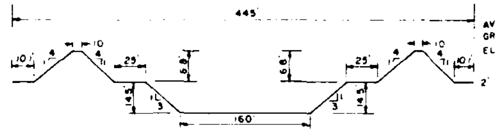

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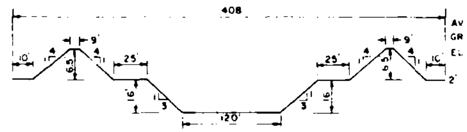

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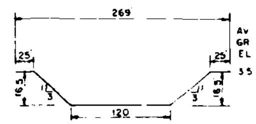


7. FLEMING CANAL TO BAYOU VILLARS - DISTANCE = 25,000'

NOT TO SCALE

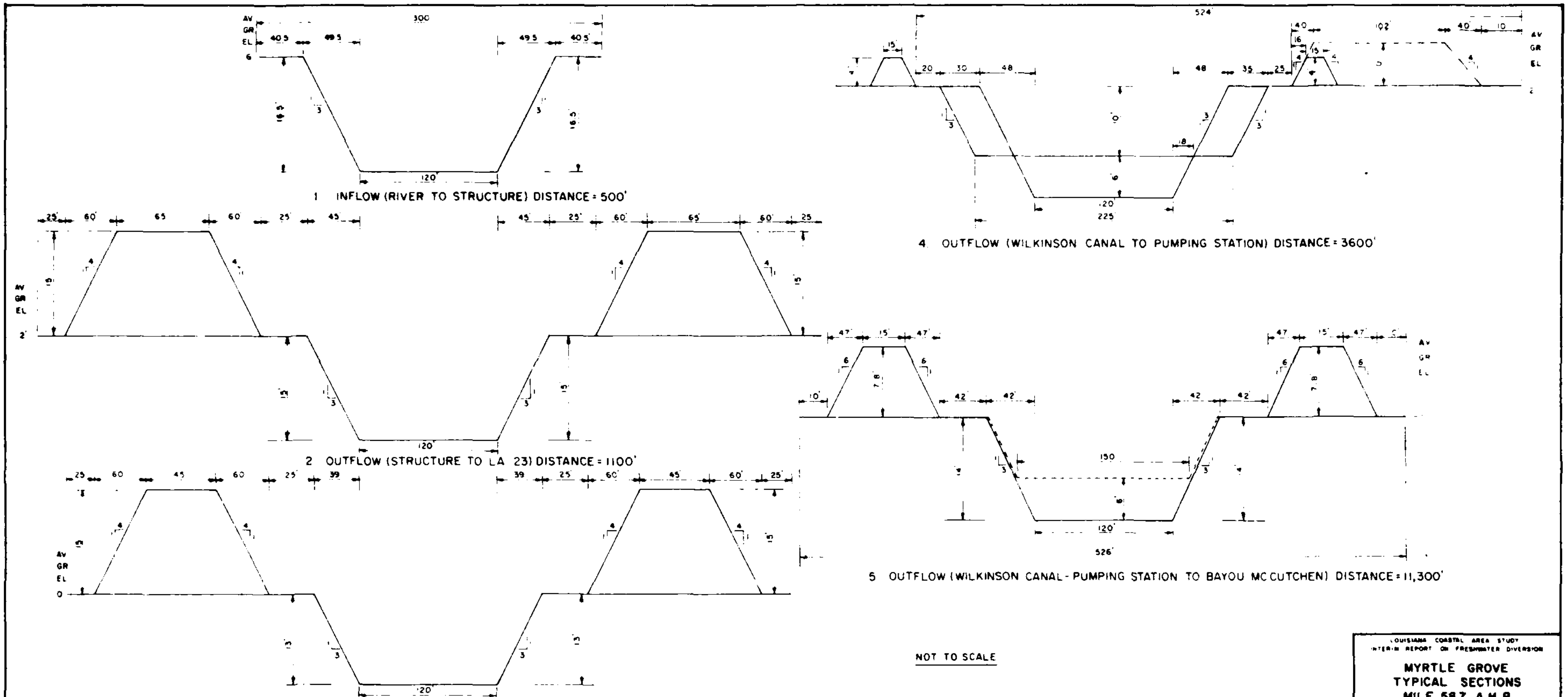
LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

OAKVILLE
TYPICAL SECTIONS
MILE 70.4 AHP

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

APRIL 1982 FILE NO. H-2-29437

PLATE C-38



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2 OUTFLOW (STRUCTURE TO LA 23) DISTANCE = 1100'

3. OUTFLOW (LA 23 TO WILKINSON CANAL) DISTANCE = 1800'

4 OUTFLOW (WILKINSON CANAL TO PUMPING STATION) DISTANCE = 3600'

5 OUTFLOW (WILKINSON CANAL - PUMPING STATION TO BAYOU MC CUTCHEN) DISTANCE = 11,300'

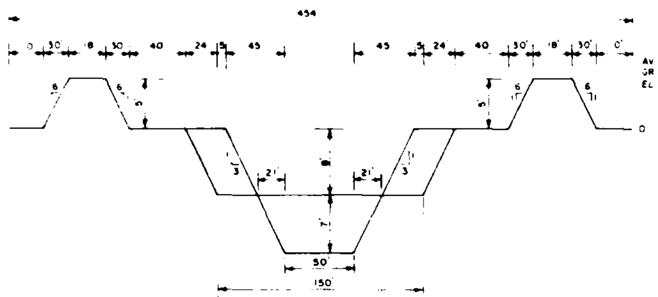
LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

MYRTLE GROVE
TYPICAL SECTIONS
MILE 58.7 A H P

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

APRIL 1982 FILE NO. H-2-29437

PLATE C-34



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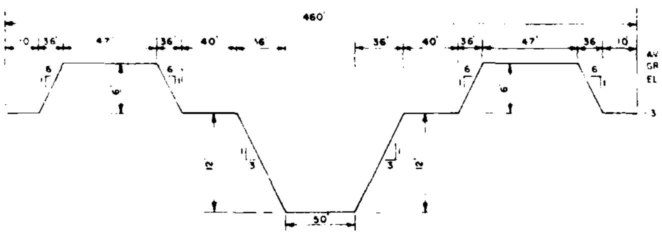
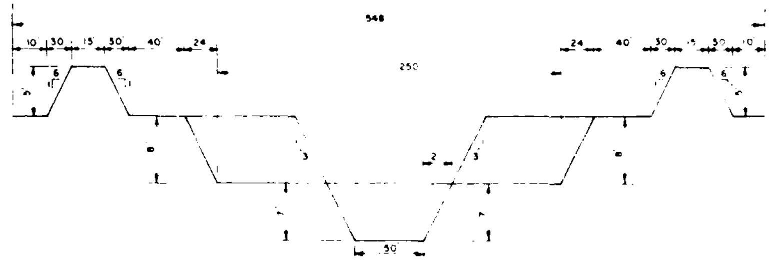


7 OUTFLOW - LANDCUT WILKINSON CANAL TO BAYOU DUPONT - DISTANCE = 6,700'



8 OUTFLOW - BAYOU MC CUTCHEN - DISTANCE 8300'

NOT TO SCALE

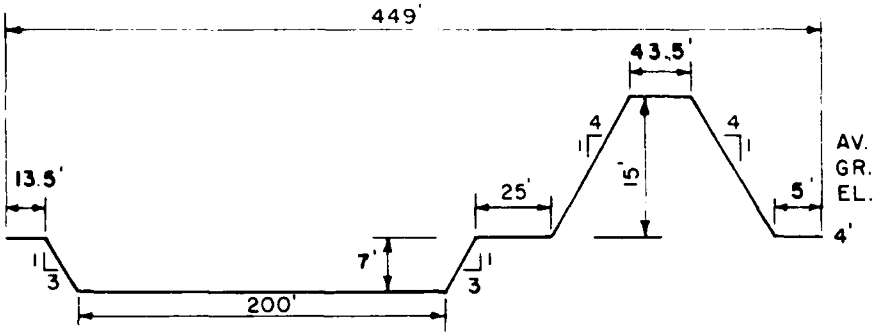
LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

MYRTLE GROVE
TYPICAL SECTIONS
MILE 58.7 AHP

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

APRIL 1982 | FILE NO. H-2-29437

PLATE



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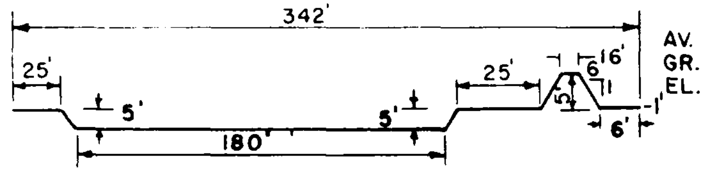

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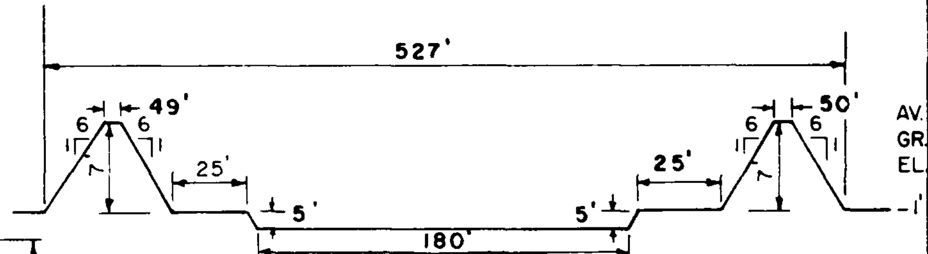

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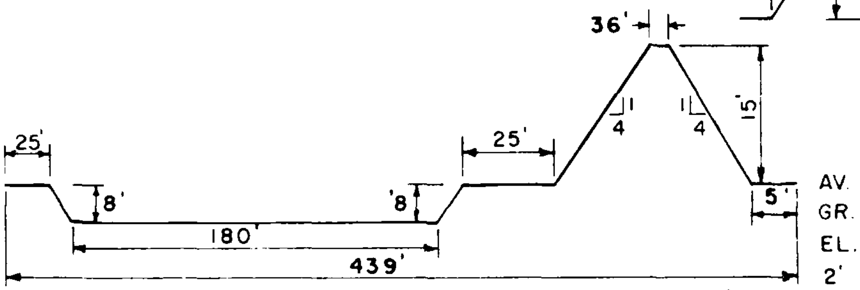


EARTH CHANNEL I - DISTANCE = 2550'

NOT TO SCALE

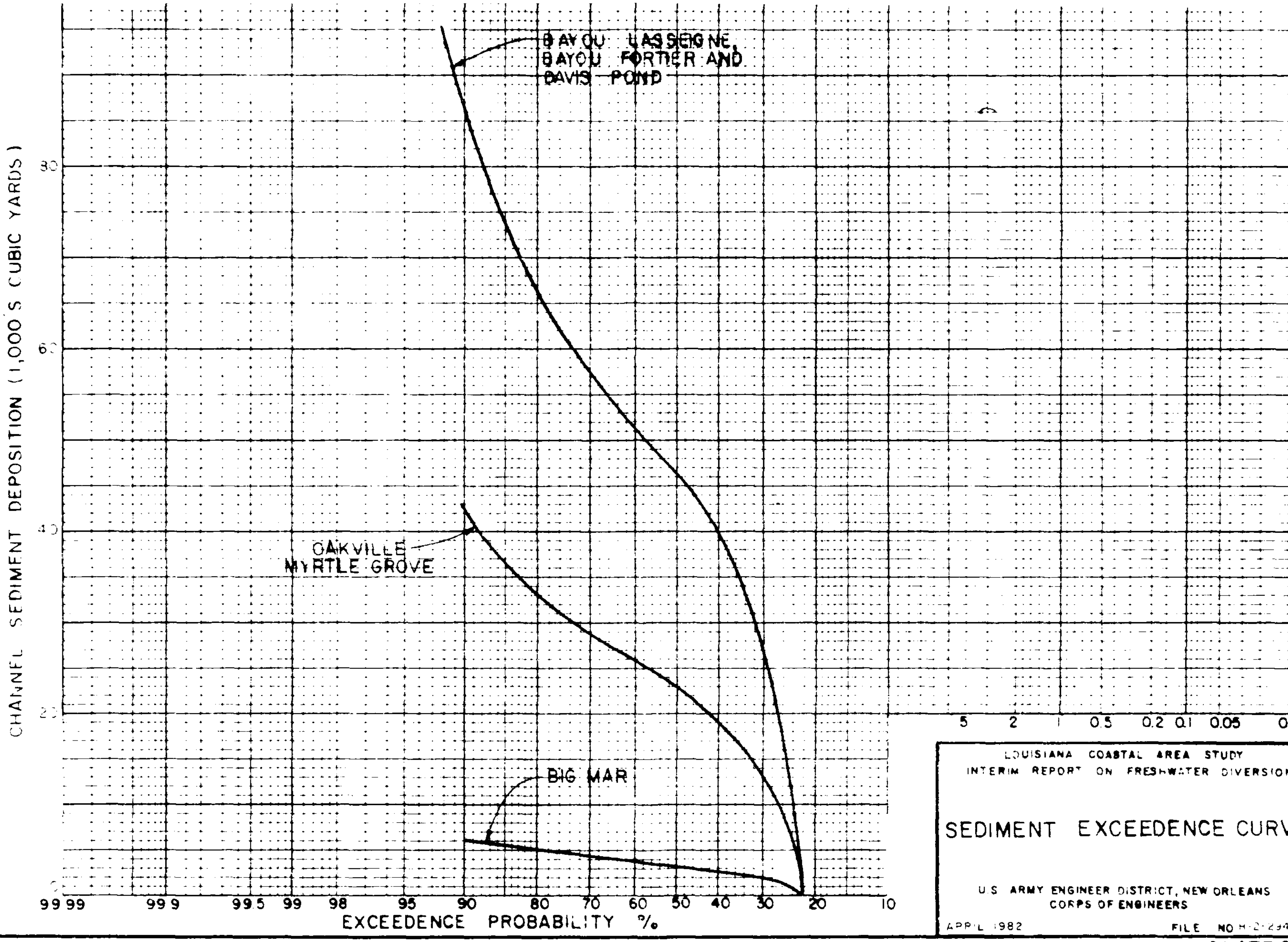
LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

NEAR CAERNARVON
TYPICAL SECTIONS
MILE 81.5 AHP

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

APRIL 1982 FILE NO. H-2-29437

PLATE C-41



LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

SEDIMENT EXCEEDENCE CURVE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

APRIL 1982 FILE NO. H-2-29437

PLATE C-42

APPENDIX D

NATURAL RESOURCES

AD-A152 704 LOUISIANA COASTAL AREA LOUISIANA FRESHWATER DIVERSION TO BARATARIA AND BR..(U) ARMY ENGINEER DISTRICT NEW ORLEANS LA D L CHEW SEP 84

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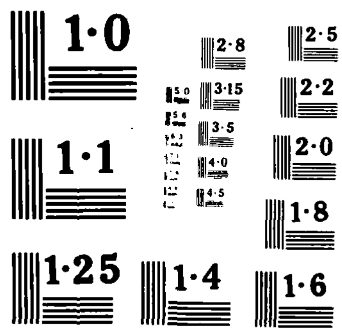
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3·5
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1·6

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to
Barataria and Breton Sound Basins

Appendix D

N A T U R A L   R E S O U R C E S

D.0.1 This appendix contains technical information and methodologies concerning the natural resources of the study area. The appendix consists of five separate sections. Section 1 contains an alphabetized list of common names of plants discussed in the report with corresponding scientific names. Section 2 contains the Biological Assessment of Threatened and Endangered Species and Amendment thereof. Section 3 contains information concerning habitat acreages that would be affected by construction of the various freshwater diversion routes. Section 4 contains information concerning methodologies used for estimating the with and without project habitat acreages for the Barataria and Breton Sound Basins. Section 5 contains an explanation of the methodology and concepts used for estimating commercial fish and wildlife benefits. Section 6 consists of the Fish and Wildlife Coordination Act Report.

Section 1 LIST OF COMMON AND SCIENTIFIC NAMES OF PLANTS

D.1.1. This section contains an alphabetized list of the common names of plants discussed in the report with corresponding scientific names. The list is taken from Montz (1975a, 1975b) who used the following taxonomic sources: Correll and Johnston (1970); Fernald (1950); Gleason (1968); Hitchcock (1950); Lasseigne (1973); Radford, Ahles, and Bell (1968); and Small (1933).

LIST OF COMMON AND SCIENTIFIC NAMES OF PLANTS

Alligatorweed	*Alternanthera philoxeroides*
American elm	*Ulmus americana*
Baldcypress	*Taxodium distichum*
Blackgum	*Nyssa sylvatica*
Black mangrove	*Avicennia germinans*
Black rush	*Juncus roemerianus*
Black willow	*Salix nigra*
Bulltongue	*Sagittaria falcata*
Bullwhip	*Scirpus californicus*
Buttonbush	*Cephalanthus occidentalis*
Carolina ash	*Fraxinus caroliniana*
Cattail	*Typha spp.*
Cross vine	*Anisostichus capreolatus*
Deciduous holly	*Ilex decidua*
Deerpea	*Vigna luteola*
Drummond red maple	*Acer drummondii*
Duckweed	*Lemna spp.*
Dwarf spikerush	*Eleocharis parvula*
Eastern baccharis	*Baccharis halimifolia*
Elderberry	*Sambucus canadensis*
Frogbit	*Limnobium spongia*
Glasswort	*Salicornia spp.*
Great duckweed	*Spirodela polyrhiza*
Green ash	*Fraxinus pennsylvanica*
Greenbriars	*Smilax spp.*
Green hawthorn	*Crataegus viridis*
Hackberry	*Celtis laevigata*
Honeylocust	*Gleditsia triacanthos*
Ladies eardrops	*Brunnichia cirrhosa*
Leafy threesquare	*Scirpus robustus*
Live oak	*Quercus virginiana*
Lizard's tail	*Saururus cernuus*
Maidencane	*Panicum hemitomon*

Marsh elder	*Iva frutescens*
Mayhaw	*Crataegus opaca*
Nuttall oak	*Quercus nuttallii*
Oystergrass	*Spartina alterniflora*
Palmetto	*Sabal minor*
Pennywort	*Hydrocotyl spp.*
Peppervine	*Ampelopsis arborea*
Pickerelweed	*Pontederia cordata*
Poison ivy	*Rhus radicans*
Pumpkin ash	*Fraxinus tomentosa*
Rattan vine	*Berchemia scandens*
Rattlebox	*Daubentonia drummundii*
Roseau	*Phragmites australis*
Saltgrass	*Distichlis spicata*
Saltwort	*Batis maritima*
Sawgrass	*Cladium jamaicense*
Smartweed	*Polygonum spp.*
Spiderlily	*Hymenocallis occidentalis*
Swamp lily	*Crinum americanum*
Sweetgum	*Liquidambar styraciflua*
Three-cornered grass	*Scirpus olneyi*
Titi	*Cyrilla racemiflora*
Trumpet creeper	*Campsis radicans*
Tupelogum	*Nyssa aquatica*
Virginia creeper	*Parthenocissus quinquefolia*
Virginia willow	*Itea virginica*
Walter's millet	*Echinocloa walteri*
Water elm	*Planera aquatica*
Water hyacinth	*Eichhornia crassipes*
Watermeal	*Wolffia spp.*
Water oak	*Quercus nigra*
Water paspalum	*Paspalum fluitans*
Waxmyrtle	*Myrica cerifera*
Widgeongrass	*Ruppia maritima*
Wild millet	*Echinochloa crusgalli*
Wiregrass	*Spartina patens*

LITERATURE CITED

Correll, D.S., and M.C. Johnston. 1970. Manual of the Vascular Plants of Texas. Texas Research Foundation, Renner.

Fernald, M.L. 1950. Gray's Manual of Botany. American Book Co., ed. 8, New York.

Gleason, H.A., 1968. The New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada. Hafner Publishing Co., New York.

Hitchcock, A.S. 1950. Manual of the Grasses of the United States. US Government Printing Office, Washington.

Lasseigne, A. 1973. Louisiana Legumes. Southwestern Studies, University of Southwestern Louisiana, Lafayette.

Montz, G.N. 1975a. Master List of Herbs, Fern and Fern Allies, and Vines of the New Orleans District. US Army Corps of Engineers, New Orleans, mimeograph report, 72 pp.

Montz, G.N. 1975b. Master List of Trees and Shrubs of the New Orleans District. US Army Corps of Engineers, New Orleans, mimeograph report, 30 pp.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1968. Manual of the Vascular Flora of the Carolinas. University North Carolina Press, Chapel Hill.

Small, J.K. 1933. Manual of the Southeastern Flora. University North Carolina Press, Chapel Hill.

Section 2. BIOLOGICAL ASSESSMENT OF THREATENED AND ENDANGERED SPECIES

D.2.1. This section contains a series of Biological Assessments addressing the impacts of the proposed project on threatened and endangered species and their critical habitat. It was necessary to prepare amendments to the original assessment due to relocation of the freshwater diversion site in the Barataria Basin from Bayou Lasseigne to Davis Pond and to provide supplemental information requested by the US Fish and Wildlife Service. The section also includes copies of correspondence between the New Orleans District and the US Fish and Wildlife Service and National Marine Fisheries Service concerning endangered and threatened species in the study area.

IN REPLY REFER TO
LMNPD-RE

4 June 1981

Mr. Harold Allen
Acting Regional Director
National Marine Fisheries Service
9450 Koger Blvd.
St. Petersburg, FL 33702

Dear Mr. Allen:

In compliance with Section 7(c) of the Endangered Species Act Amendments of 1978, we are requesting information with respect to the threatened and/or endangered species in the study area for the study "Louisiana Coastal Area, Freshwater Diversion for Breton Sound, Barataria Basin, and Terrebonne Basin." The purposes of the proposed work include improvement of wildlife and fisheries production, reduction of saltwater intrusion, enhancement of vegetative growth, and restoration of coastal wetlands.

This office requests a list of threatened and endangered species that may be affected by this project. Please include any species under consideration, but not yet formally listed.

A project description with attached location maps of the various features of the proposed project is inclosed.

Sincerely,

1 Incl
As stated

JAMES F. ROY
Chief, Planning Division

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southeast Region
9450 Koger Boulevard
St. Petersburg, FL 33702

June 16, 1981 F/SER64:DLP

James F. Roy
:, Planning Division
Orleans District, U. S. Corps of Engineers
). Box 60267
Orleans, LA 70160

Mr. Roy:

This is in response to your letter of June 5, 1981, which requested rmation about species which are listed or proposed to be listed as 'ided by the Endangered Species Act. Your area of interest is a osed project for freshwater diversion in the Breton Sound and taria and Terrebonne Basin above river mile 70 of the Mississippi r, Louisiana.

We have reviewed the proposed project and have determined that no ies of listed sea turtles or whales are likely to occur in the osed project area. This concludes consultation responsibilities r Section 7 of the Endangered Species Act of 1973. However, ultation should be reinitiated if new information reveals impacts he identified activity that may effect listed species or their ical habitat, the identified activity is subsequently modified or w species is listed, or critical habitat determined that may be cted by the proposed activity.

Sincerely yours,

Charles Oravetz

for D. R. Ekberg
Chief, Environmental and Technical
Services Division

Atlanta, GA
Jackson, MS

LMNPD-RE

23 September 1980

Mr. Gary Hickman
Area Manager
US Fish and Wildlife Service
200 East Pascagoula Street
Suite 490
Jackson, MS 39201

Dear Mr. Hickman:

In compliance with Section 7(c) of the Endangered Species Act Amendments of 1978, we are requesting information with respect to the listed and proposed threatened and endangered species in the study area for the study "Louisiana Coastal Area, Freshwater Diversion for Breton Sound, Barataria Basin and Terrebonne Basin." The purposes of the proposed work include improvement of wildlife and fisheries production, reduction of saltwater intrusion, enhancement of vegetative growth and restoration of coastal wetlands.

Description with attached location maps of the various features of the proposed project is inclosed.

Sincerely,

1 Inclosure
As stated

JAMES F. ROY
Chief, Planning Division

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
200 EAST PASCAGOULA STREET, SUITE 300
JACKSON, MISSISSIPPI 39201

October 15, 1980

Colonel Thomas A. Sands
District Engineer
New Orleans District
Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160

Dear Colonel Sands:

This is in response to a letter from your office dated September 23, 1980, requesting information on listed and proposed threatened and endangered species that may be affected by the proposed Louisiana Coastal Area, Freshwater Diversion for Breton Sound, Barataria Basin and Terrebonne Basin Project (Log number 4-3-80-007).

A number of bald eagle nests occur within the Louisiana marsh. Several of these nests are found between Lac des Allemands and Lafitte, an area of primary project activity.

The brown pelican can be expected along the coastline especially around the mouth of Barataria Bay.

The Arctic peregrine falcon is a transient visitor to the area occasionally occurring along the coast during the fall and spring migration.

If you determine this to be a construction project, Section 7(c) of the Endangered Species Act, as amended, requires that you prepare a biological assessment identifying any listed species, species proposed to be listed, and Critical Habitat which may be affected by the proposed project, and determine the nature and extent of impact that the project may have on such species. Section 7(c) also stipulates that the biological assessment shall be completed within 180 days after the date on which initiated and before any contract for construction is entered into and before construction is begun. The assessment should include, as a minimum:

1) an on-site inspection of the area;
2) interviews with recognized experts on the species at issue;
3) a review of literature and other pertinent scientific data;
4) an analysis of the effects of the proposal on the species; and
5) a review of alternative actions that may provide conservation measures.

Table [illegible]. Relative percentage of habitats surrounding the Lake Cataouatche bald Eagle nest as determined by Dugoni (1980).

RADII	HABITAT							
	Lakes	Marsh Ponds	Bayous	Swamp	Marsh	Pipeline Canals	Pipeline rights-of-way	Developments
1 Mile (6 km)	11.6	5.9	5.1	17.1	55.6	3.4	1.1	0.1
2 Mile (3.2 km)	16.0	7.1	5.6	23.5	44.5	2.5	0.6	0.1
3 Mile (4.8 km)	17.2	6.0	4.6	23.1	46.2	2.2	0.1	0.2

marsh near the nest is largely a floating type, and the vegetation includes hydrocotyle (Hydrocotyle), water primrose (Ludwigia), and cattail (Typha). The surrounding marshes are characterized by maidencane (Panicum), bulltongue (Sagittaria), and spike rush (Eleocharis), and nearby swamps are predominately baldcypress (Taxodium) and tupelogum (Nyassa) (Shealy, 1981). The habitats within one and three miles, 1.6 Km and 3.2Km, respectively, can be found in Table 1.

Generally, the adults arrive at the nest in mid-September and remain in the area into the spring. In November, or early December, incubation begins, and the chicks hatch in late December or January. The young typically fledge in March, and immature and adult birds leave the breeding territory by May. The nest has been relatively successful, producing one to two young per year since, at the minimum, the 1974-1975 season. Reproductive data on the Lake Cataouatche nest can be found in Table 2.

About 75% of the perching, soaring, and foraging by the pair is spent in the marshes to the west and north of the nest, and at a distance of 900 to 3,000 feet (275-915 m). Although most activity occurs between 900 and 1,500 feet (275-450 m) of the nest, the pair generally forages for mammals, birds, and fish in the open-water marsh ponds 1,500 to 2,100 feet (450-650 Km) to the north (Shealy, 1981).

In the bird's diet, mammals represent 21% of the prey taken, birds 51%, and fish 28%. Nutria comprize 18% of the mammals; ducks represent 33%, and rails 15%, of the birds; and freshwater catfish compose 15% of the fish (Dugoni, 1981). The pair is also reported to scavenge from a garbage dump located about 4.5 miles (7.2 Km) from the nest. Additional information on the prey captured can be found in Table 3.

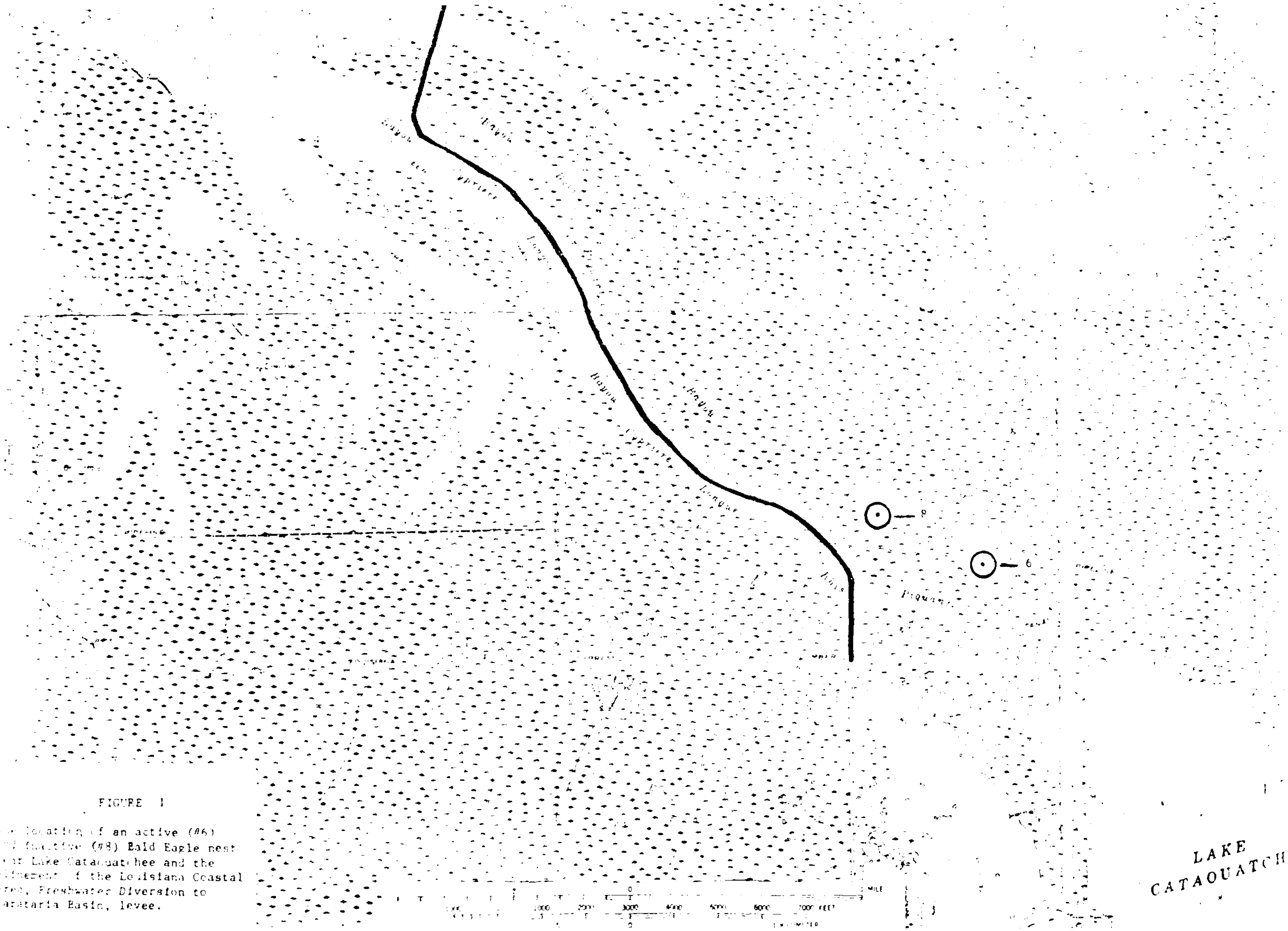

FIGURE 1

The location of an active (#6) and inactive (#8) Bald Eagle nest near Lake Cataouatchee and the alinement of the Louisiana Coastal Area, Freshwater Diversion to Barataria Basin, levee.

early 1970's, the bird was uncommon (Lowery, 1974). Eagles' nests in Louisiana are predominantly located in flooded, second growth bald cypress-tupelogum and mixed hardwood swamps. These areas are common on the backslopes of remnant deltaic distributaries, and most of the nests are in the old delta between the Mississippi River and the Atchafalaya River. During the 1977-1980 breeding seasons, 30 eagle nests were known to exist in Louisiana, and all of these, but one, were in Terrebonne, Assumption, St. Mary, Jefferson, and St. Charles Parishes. Of these 30 nests, 19 were active and 8 were alternate sites. The remainder were inactive or the status was unknown. The predominant nesting tree in Louisiana is the bald cypress (93 percent) and the remainder live oaks. The nesting season in Louisiana is from September through May (Dugoni, 1980).

Of 10 active Louisiana nests examined, the eagles were found to feed largely on birds (42 percent) and fish (42 percent). The predominant preys, which accounted for about half the birds diet, were freshwater catfish and American Coots (Dugoni, 1980). Their prey is typical of that found in shallow waters.

Organochlorine residue analysis of four prey items indicated 86 percent contained residues (Dugoni, 1980). Subnormal clutch size and hatching failure may be responsible for the reduced reproductive output in Louisiana. The average annual production of young fledged per active nest suggest that clutch failure, not nestling mortality, inhibits the eagle population in Louisiana.

One Bald Eagle nesting territory could be affected by the proposed project. This is breeding territory #6 (nests #6 and #8) of Dugoni (1980), and is located in the northwest corner of Lake Cataouatche near Bois Piquant (Figure 1). The active nest (#6), which is located in a baldcypress-tupelogum mixed hardwood habitat on a ridge, is about 100 feet (30m) high in a live cypress tree. The nest tree is located near a cleared pipeline right-of-way and is adjacent to, and overlooks, an extensive area of fresh marsh and shallow water. The

difficulties were encountered in obtaining available information. Data on the impact of sub-level toxic material and bioaccumulation on the Bald Eagles are lacking; thus, the impact of these materials on the birds are speculative.

II. Present Conditions

The Southern Bald Eagle (Haliaeetus leucocephalus leucocephalus) is a large raptor which has undergone a pronounced population decline since the late 1940's. Including the northern races, there were an estimated 750 active nests in the continental United States in 1975 (Snow, 1973). The greatest factor in the eagle decline is the reduced reproduction caused by pesticide accumulation through the food chain. It appears that high residue levels, especially of dieldrin, have resulted in thin eggshells. Other factors affecting the population are shooting, electrocution, severe weather, habitat loss, and human disturbance.

The opportunistic Bald Eagle is generally found in coastal areas or along rivers and lakes where they feed on dead, dying, or live prey. Although the eagles' food is variable, they forage largely on fish and birds. The fish species captured include shad, bass, catfish, gar, mullet, and sunfish, while birds are primarily ducks and coots.

Eagles prefer to nest in the largest tree of a stand and place the nest below the crown. Usually a clear flight path to water, a good perching tree, and open view of the surrounding area are selected. In the southeast, nests are generally constructed in living trees. The eagle is highly site tenacious. In Alaska, the territorial area varies from 28 to 112 acres, and averages 57 (Snow, 1973).

During the turn of the century, the Bald Eagle was common along the coastal and wetland areas of southern Louisiana (Bailey, 1919, in Dugoni, 1980). Concern for the eagle began in the 1930's, and by the

BIOLOGICAL ASSESSMENT AMENDMENT

THREATENED AND ENDANGERED SPECIES

LOUISIANA COASTAL AREA, LOUISIANA

Freshwater Diversion to Barataria and Breton Sound Basins

I. Introduction

This amendment complements the 1980 biological assessment filed with the US Fish and Wildlife Service, and addresses the potential impacts of relocating the Barataria Basin freshwater diversion site from Lac des Allemands to Lake Cataouatche. The Louisiana Coastal Area Study examines the potential for freshwater introduction from the Mississippi River into the Barataria and Breton Sound Basins in order to maintain the 15 parts per thousand (ppt) isohaline at an area known as the "Ford Line". Two sites, Davis Pond in St. Charles Parish and Big Mar in Plaquemines Parish, are under consideration. The Davis Pond structure would divert water into Barataria Basin by way of a 2.3-mile channel into the marshes above Lake Cataouatche, and would have a maximum flow of 10,650 cubic feet per second (cfs). The Big Mar structure would transfer water into Breton Sound via a 1.7-mile channel to Big Mar, and would have a maximum flow of 6,600 cfs. The potential benefits of the proposed project would be decreased saltwater intrusion, increased wetland productivity, and reduced land loss, while impacts would include the introduction of pollutants and cooler water, and loss of 394 acres (Lake Cataouatche = 305, Big Mar = 89) of wetland to construct the diversion channels.

The Bald Eagle is the only threatened or endangered species that would be affected by this proposed project modification. This assessment is the result of several visits to the area, conversations with knowledgeable persons, and a review of current literature. The historic and current occurrences of the Bald Eagle in Louisiana and the study area are summarized, and the potential impacts and cumulative effects of the proposed project are examined. No

DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT CORPS OF ENGINEERS
P O BOX 60267
NEW ORLEANS LOUISIANA 70160

IN REPLY REFER TO
LMNPD-RE

28 January 1983

Mr. Dennis B. Jordan
US Fish and Wildlife Service
Jackson Mall Office Center
300 Woodrow Wilson Avenue Suite 3185
Jackson, MS 39213

Dear Mr. Jordan:

The inclosed amendment complements the 1980 biological assessment filed with the US Fish and Wildlife Service on 14 July 1981 (Log. No. 4-3-80-007). The amendment addresses the potential impacts on threatened and endangered species of relocating the Barataria Basin freshwater diversion site from Lac des Allemands to Lake Cataouatche.

We appreciate your cooperation in the preparation of this amendment. If you have any questions on the assessment, please feel free to contact Mr. E. Scott Clark of this office, telephone (504) 838-2521.

Sincerely,

CLETIS R. WAGAHOFF
Chief, Planning Division

1 Incl
Biological Assessment

Copy furnished: w/incl

Mr. Dave Fruge
Ecological Services
USFWS
P. O. Box 4305
Lafayette, Louisiana 70502

project may cause significant adverse impacts to any threatened or endangered species or its critical habitat.

Conclusions With Respect to Overall Project Impacts on Species

The USACE concludes, based on this assessment, that the construction, operation and/or maintenance of the subject project, as proposed, would have no significant adverse impact on any threatened or endangered species or its critical habitat. Moreover, fresh water introduction would have a beneficial effect on the endangered species in question by increasing the quality of their habitats and the availability of food sources.

During its infrequent visits to the study area, the Arctic peregrine falcon apparently prefers to remain close to the gulf coast near sizable populations of ducks, seabirds and shorebirds. It does not nest in the study area. Construction would have no direct impacts on this species.

Because both the bald eagle and the brown pelican are fish-eating birds, consideration must be given to possible indirect effects of Mississippi River pollutants bioaccumulating in fish living in areas where fresh water would be introduced. These effects relate primarily to the impact of chlorinated hydrocarbons on the species' reproductive success. Several eagle nests are near fresh lakes and bayous and estuarine lakes and bays where freshwater introduction would take place; it is assumed that the occupants of these nests feed on fish which live in those nearby water bodies. Also, brown pelicans feed in bays and sounds near the coast. There is a scarcity of reliable water quality data for the Mississippi River, Lac des Allemands, Barataria Bay and adjacent estuarine areas. To date, no projections of post-project water quality have been performed. The scarcity of water quality data for the study area, together with the lack of information dealing with bioaccumulation and safe levels of toxic substances in water as they relate to the bald eagle and brown pelican, make a determination of potential impact on these species difficult and speculative. However, it is acknowledged that a problem may exist. As water quality monitoring and other planning studies continue, USACE will keep local and area USFWS representatives informed of progress concerning project impacts on these species.

Beneficial effects

As discussed in the USFWS draft Planning Aid Report dated 15 January 1980, fresh-water introduction would also have beneficial impacts on the endangered species in question. Prevention or reduction of saltwater intrusion would result in preservation and rejuvenation of existing baldcypress-tupelogum swamps, a favored nesting habitat of the bald eagle. Increased nutrient and freshwater input would result in increased availability of food fish through enhancement of marsh production, phytoplankton production, and low salinity nursery areas. Preservation and enhancement of existing marshes would also assure future availability of wildlife food sources of bald eagles and peregrine falcons. Bald eagles prey on species such as ducks, coots, mustrat, nutria, and rabbits and peregrine falcons feed primarily on ducks, coots and a variety of seabirds and shorebirds.

Difficulties Encountered in Obtaining Data and Completing Study

The lack of water quality data and the lack of information dealing with bioaccumulation and safe levels of toxic substances in water, as they might relate to the bald eagle and brown pelican, made a determination of potential impact on these species difficult and speculative. No difficulties were encountered in determining which threatened and endangered species could be expected to occur in the project area. The USFWS will be informed of any new development which indicate that the

Maps depicting the various diversion routes are attached.

Relationship of Project to Threatened and Endangered Species

In the letter to USFWS dated 23 September 1980, USACE requested information on listed and proposed threatened and endangered species which may be affected by the proposed project. In the USFWS reply to that letter, dated 15 October 1980, the following information was furnished:

a A number of bald eagle nests occur within the Louisiana marsh. Several of these nests are found between Lac des Allemands and Lafitte, an area of primary project activity.

b. The brown pelican can be expected along the coastline especially around the mouth of Barataria Bay.

c. The Arctic peregrine falcon is a transient visitor to the area occasionally occuring along the coast during the fall and spring migrations.

Examination of the USFWS Notice of Review of Plant Taxa for Listing as Endangered or Threatened Species, as published in the 15 December 1980 Federal Register, indicated that no listed or proposed endangered or threatened plants are known to occur in the study area.

Results of Surveys and Other Studies

During preliminary reconnaissance trips and during habitat evaluation of the project sites by USACE and USFWS personnel in September - October 1980 and February and April 1981, none of the threatened or endangered species in question were observed. No surveys or other studies for the purpose of determining the presence or absence of threatened or endangered species in the project area were undertaken.

Consideration of Effects on Threatened and Endangered Species or Their Critical Habitat

Adverse effects

A total of eight bald eagle nests occur within the study area, including two on Bayou Barataria near Lafitte, two near Lake Cataouatche, two near Paradis, and two on the northeast shore of Lac des Allemands. None of these nests would be affected by construction at any of the proposed sites. The Lac des Allemands nests, which are the most proximate, are 3 miles from the closest proposed construction area.

Nesting and feeding areas for the brown pelican are far removed from the proposed construction sites. Construction would have no direct impacts on this species.

BIOLOGICAL ASSESSMENT OF THREATENED AND ENDANGERED SPECIES

LOUISIANA COASTAL AREA, FRESHWATER DIVERSION FOR
BRETON SOUND, BARATARIA BASIN AND TERREBONNE BASIN

Purpose

This assessment is submitted to the US Fish and Wildlife Service (USFWS) to fulfill requirements of the US Army Corps of Engineers (USACE) in adhering to Section 7, as amended, of the Endangered Species Act of 1973. In a letter dated 23 September 1980, the USACE requested from the USFWS information on listed and proposed threatened and endangered species which may be affected by the proposed Louisiana Coastal Area, Freshwater Diversion for Breton Sound, Barataria Basin and Terrebonne Basin project. Data relating to studies and observations which have been made concerning threatened and endangered species are presented. In addition, conclusions of the USACE concerning project impacts on those species are given.

Project Setting

The areas affected by the proposed project would include Hydrologic Units II (Breton Sound) and IV (Barataria Basin) of the Louisiana coastal zone. Alternatives for diversion of fresh water into Hydrologic Unit V (Terrebonne Basin) were considered; however, none are contained in the tentatively selected plan.

Tentatively Selected Plan

The possible diversion sites are at the following locations, all in southeastern Louisiana:

a. A diversion structure through the westbank levee of the Mississippi River at about river mile 141, then via a dredged channel to Lac des Allemands, a total distance of approximately 6.0 miles.

b. A diversion structure through the westbank levee at about river mile 131, then via a dredged channel to Bayou Fortier to Lac des Allemands, a total distance of approximately 7.0 miles.

c. A diversion structure through the westbank levee at river mile 70, then via a dredged canal in the vicinity of Hero Canal to the Gulf Intracoastal Waterway to Barataria Waterway to Barataria Bay, a total distance of approximately 10 miles.

d. A diversion structure through the eastbank levee at about river mile 81, then via a dredged canal in the vicinity of Caernarvon Canal to Big Mar, then through connecting waterbodies to Breton Sound, a total distance of approximately 5 miles.

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
200 EAST PASCAGOULA STREET, SUITE 300
JACKSON, MISSISSIPPI 39201

July 28, 1981

Mr. James F. Roy
Chief, Planning Division
New Orleans District, Corps of Engineers
P.O. Box 60267
New Orleans, Louisiana 70160

Dear Mr. Roy:

This is in response to your letter of July 14, 1981, transmitting the Biological Assessment on the Louisiana Coastal Area Freshwater Diversion for Breton Sound, Barataria Basin and Terrebonne Basin project (log number 4-3-81-007) and requesting our concurrence that the proposed project would have no adverse impact on the bald eagle, brown pelican, or the Arctic peregrine falcon.

After a review of the Biological Assessment as well as data in our Jackson Area Office files, we concur with your determination that the project will have no significant affect on the aforementioned species.

Unless there are major modifications in the project or changes in the listing of species that could be affected by the project, this consultation is now concluded.

Please advise if we can be of additional assistance.

Sincerely,

Dennis B. Jordan

acting for

Gary L. Hickman
Area Manager

cc: RD, FWS, Atlanta, GA (ARD-FA/SE)
ES, FWS, Lafayette, LA
Louisiana Department of Wildlife and Fisheries
New Orleans, LA

IN REPLY REFER TO
LMNPD-RE

14 July 1981

Mr. Gary Hickman
Area Manager
US Fish and Wildlife Service
200 East Pascagoula Street
Suite 490
Jackson, Mississippi 39201

Dear Mr. Hickman:

In accordance with the Endangered Species Act of 1973, as amended, a Biological Assessment which addresses the impacts of the Louisiana Coastal Area, Freshwater Diversion for Breton Sound, Barataria Basin and Terrebonne Basin project is submitted. Please refer to log number 4-3-80-007 as assigned to this project by your letter of 15 October 1980.

Based on this Biological Assessment, the US Army Corps of Engineers, New Orleans District has determined that the construction and/or maintenance of the subject project as proposed would have no adverse impact on the subject species.

Based on these determinations, it is our opinion that initiation of consultation is not necessary at this time.

Sincerely,

1 Incl
As stated

JAMES F. ROY
Chief, Planning Division

If you determine this action not to be a construction project, a biological assessment is not required, however, you still have an obligation to review the activity to determine if it may affect listed species or Critical Habitat and to initiate formal consultation pursuant to Section 7(a), if you find that such an affect may occur.

The term construction projects is defined to include only those construction activities that are major Federal actions significantly affecting the quality of the human environment. These are actions for which environmental impact statements are normally required.

For additional information regarding your obligations under the Endangered Species Act, contact Mr. Ernest H. Douglas, Endangered Species Specialist, U. S. Fish and Wildlife Service, 200 East Pascagoula Street, Suite 300, Jackson, Mississippi 39201, telephone FTS 490-4900, commercial (601) 960-4900.

We appreciate your concern for endangered species.

Sincerely,

Gary L. Hickman

Gary L. Hickman
Area Manager

cc: RD, FWS, Atlanta, GA. (ARD-FA/SE)
ES, FWS, Lafayette, LA.
Department of Wildlife and Fisheries
New Orleans, LA.

Table 2. Reproductive data on the Lake Cataouatche Bald Eagle nest in the vicinity of the Louisiana Coastal Area project.

YEAR	SOURCE	OCCUPIED[a]	ACTIVE[b]	SUCCESS[c]
1974-75	Payne, 1975	Y	?	1
1975-76	Hawes, 1976	Y	?	1
1976-77	Dubuc[d]	Y	?	2
1977-78	Dugoni, 1980	Y	2[e]	2
1978-79	Dugoni, 1980	Y	2	1
1979-80	Dugoni, 1980	Y	3	2
1980-81	Dubuc[d]	Y	2	2
1981-82	Dubuc[d]	Y	?	1

[a] Adults at the nest; Y=Yes, N= No
[b] Number of eggs
[c] Number of fledglings
[d] Letters to USFWS, and personnel communications with the USCEC
[e] Minimum number

Table 3. The percentage of prey items collected from the Lake Cataouatche Bald Eagle nest in 1979 (Dugoni, 1980).

PREY	PERCENTAGE	
	By Prey Class	By Total Prey
BIRDS (%=51.3 N=20)		
Mottled Duck	15.0	7.7
Blue-winged teal	10.0	5.1
Redhead Duck	10.0	5.1
Gadwall	15.0	7.7
Canvasback	5.0	2.6
Wood Duck	10.0	5.1
American Coot	15.0	7.7
Common Gallinule	15.0	7.7
Ring-billed Gull	5.0	2.6
FISH (%=28.2; N=11)		
Freshwater Catfish	54.5	15.4
Bowfin	9.1	2.6
Freshwater Drum	9.1	2.6
Largemouth Bass	18.2	5.1
Longnose Gar	9.1	2.6
MAMMALS (%=20.5; N=8)		
Nutria	87.5	17.9
Swamp Rabbit	12.5	2.6

III. Impacts

With the present plan, a 5-foot high by 10-foot wide levee would be constructed on a 160-foot right-of-way along Bayou Cupriere Longue and Bayou Bois Piquant as shown on Fig. 1. Levee construction activities would take place about 3,000 feet (900 m) from nest #6, the active nest, and about 1,800 feet (550 m) from nest #8, the old, alternate nest. Construction activities within one mile of the nest would be restricted to the non-breeding season from mid-May through mid-September. No work would be performed within one-half mile of the active nest. Any modification of the above would require joint approval of biologists from the US Army Corps of Engineers (USCE), US Fish and Wildlife Service (USFWS), and Louisiana Department of Wildlife and Fisheries (LDWF).

It is not anticipated the construction would affect the eagles. The US Forest Service recommends that no activities be carried out within one-quarter mile of a nest/roost tree that would be detrimental to the site character, and other activities not be conducted during the time of egg laying through the first month after hatching (Chamberlain, 1974). Within a 120 acre zone surrounding the nest, any land practice that alter habitats are prohibited (Edwards, 1978). The USFWS guidelines recommend a minimum radius of 1,500 feet (457Km) around the nest (primary zone) in which there is no activity at any time. They also suggest a 1-mile (457m) buffer, (secondary zone) surrounding the nest in which no activities occur during the nesting season and no permanent development takes place (USFWS, undated). It appears the presence of the levee would not impact the birds. A cleared pipeline canal is currently located under the nest tree, and a 500 Kw Louisiana Power and Light Company transmission line has been proposed, and approved by the USFWS, 2,000 feet (610m) north of nest #6, and 750 (225m) feet north of nest #8. Dugoni (1980) found 3.6% of the land within a 1-mile (1.6 km) radius of the nest is man-modified habitat, as is 3.2% of the area within a 2-mile (3.2 km) radius, and 2.5% within a 3-mile (4.8 km) radius. A habitat analysis of these areas

can be found in Table 1 and seen on Figure 1. The cumulative effect of these activities are unknown, but not expected to be significant.

Non-construction impacts of the proposed project would be both beneficial and detrimental. The beneficial impacts are primarily the result of a reduction in saltwater intrusion and introduction of sediments, whereas the detrimental effects are related to the water quality of Mississippi River water.

A reduction in saltwater intrusion would result in the preservation and rejuvenation of existing swamps and marshes, a favored habitat of the Bald Eagle. In recent years, the area around the nest has deteriorated, especially the marshes. The 24,000 acres of fresh marsh present in the Lake Cataouatche quadrangle have decreased to 14,000 acres from 1956 to 1978, a period of 22 years. This fresh marsh has converted primarily to intermediate marsh (5,600 acres) and estuarine open water (4,600 acres). Habitat losses, of which this proposed project is designed to reduce, can be found in Table 4. About 175 acres of marsh would be created during project construction, and it is anticipated that a 4-square-mile delta would be created over the 50-year project life in the overflow area above Lake Cataouatche. This delta would be colonized by vegetation and become fresh marsh. Freshwater input would enhance the prey availability by increasing marsh productivity, phytoplankton production, and providing low salinity nursery areas. Preservation and enhancement of existing marshes would also assure future availability of prey resources.

Diversion of the Mississippi River water would raise water levels within the overflow site and introduce pollutants. During diversion, water levels within the overflow area would increase 1 to 2 feet above the present level, and these levels would be maintained by the use of weirs located along the northern shore of Lake Cataouatche. The increased levels could impact prey availability; however, this is not expected to affect the eagles. Bald eagles have an extensive foraging repertoire, and are capable of taking many animal species. A slight

Table 4. Habitat changes in the Lake Cataouatche West quadrangle from 1956 to 1978 (Wicker, 1980).

HABITAT	USFWS DESCRIPTION	YEAR 1956	YEAR 1978
Intermediate Marsh	E2EM5P6	0	5,646
Bottomland Hardwoods	PF01	0	0
Wooded Swamp	PF01/2	473	423
Bottomland Hardwoods	PF01/3	0	0
Fresh Marsh	PEM	23,952	14,224
Drained Fresh Marsh	PEMd	0	371
Fresh Water	POW	21	29
Impounded Fresh Water	POWh	84	0
Estuarine Open Water	E1OW	0	4,616
Estuarine Open Water-Oil, Gas	E1OWO	0	39
TOTAL		24,530	25,348

shift in prey consumed by this pair is anticipated because those species dependent on, or captured in, extremely shallow water (primarily catfish and swamp rabbits) would be less available. Waterfowl, which comprise a majority of the diet, would continue to be readily available.

The release of polluted Mississippi River water into the receiving site is perhaps the most critical indirect impact of the project, and one of which there is the least amount of information. This problem is compounded by the lack of data or bioaccumulation, and sub-acute levels that could significantly impact reproduction.

The Mississippi River often contains unacceptable levels of fecal coliforms, nutrients, heavy metals, phenols, pesticides, polychlorinated biphenyls, and other alien compounds, and diversion of river water would probably result in increased concentrations of cadimum, mercury, nickel, selenium, zinc, nitrogen, phosphorus, hydrocarbons, and fecal coliforms. The levels of persistant organochlorine insecticides, particularly DDT, dieldrin, and endrin, are more frequently detected in the Mississippi River than the receiving areas. Pollutant levels of the river water for selected toxic materials can be found in Table 5. These pollutant concentration in fish tissues can be seen in Table 6. Although these parameters indicate concern, especially dieldrin, no contaminants in the river have been detected at levels and freqencies that would result in immediate, irreversible harm; however, subtle, long-term effects are unknown.

IV. Sampling

Because of the potential for toxic material release from the Mississippi River, a water quality sampling program would be begun in addition to those currently performed by the numerous municipalities and state and Federal agencies.

Table 5. Average concentrations, range, and EPA criteria for selected pollutants from Mississippi River water samples near the Davis Pond diversion site. SOURCE: STORET System

POLLUTANT	NUMBER OF OBSERVATIONS	AVERAGE	RANGE	EPA CRITERIA[a]	
				Acute	Chronic
NUTRIENTS (mg/l)[b]					
Nitrate (NO_3-N)	421	0.72	0.00-5.10	-	-
Phosphate	102	0.26	0.06-0.62	-	-
HEAVY METALS (ug/l)[b]					
Cadmium	87	3.	0-25	4.5	0.037
Copper	72	21.	1-190	32.	3.6
Lead	87	20.	0-200	273.	9.3
Nickel	72	13.	2-90	2460.	127.
Mercury	167	0.4	0.0-5.5	4.1	0.2
Zinc	87	41.	0-100	440.	47.
PESTICIDES (ug/l)[c]					
Aldrin	27	0.001	0.000-0.010	3.0	-
Chlordane	26	0.008	0.000-0.100	2.4	0.004
DDT, DDE, DDE	27	0.001	0.000-0.010	1.1	0.001
Dieldrin	26	0.003	0.000-0.010	2.5	0.002
Endrin	27	0.002	0.000-0.010	0.18	0.002
Heptachlor	27	0.001	0.000-0.010	0.52	0.004
PCB's	26	0.012	0.000-0.100	-	0.014

[a]EPA fresh water life criteria. Heavy metal criteria are hardness dependent and a value of 146, which was the mean for the Luling Ferry Station, was used.
[b]Luling Ferry, St. Charles Parish, LA.
[c]New Orleans, New Orleans Parish, LA.

…5. Concentrations of selected pollutants in fish collected from the …issippi River and Lake Cataouatche. All values in ug/g (ppm) wet weight. (SOURCE: [illegible]ORET System and USFWS)

…UTANTS	MISSISSIPPI RIVER Mile 200[a]	Mile 163[b]	Mile 109[c]	LAKE CATAOUATCHE
…VY METALS				
…dmium	–	.344	<.04	<0.4
…pper	–	.344	<.05	0.58 (<0.5)
…ad	–	.67	<.05	0.06
…rcury	–	.115	0.05	0.05
…ckel	–	.400	0.1	0.15 (<0.1)
…nc	–	15.600	7.74	14.08
…TICIDES				
…drin	–	d	–	–
…lordane	c	d	–	–
…D	c	d	0.05	0.01 (<0.01)
…E	.098	.009	0.05	–
…T	c	d	0.02	–
…eldrin	.048	.049	0.12	–
…drin	.065	.002	–	–
…ptachlor	c	d	0.04	–
…B's	–	d	0.20	–

…annel catfish (Ictalurus punctatus) collected April 1975
…identified fish collected December 1977
…lue below a 0.5 ug/g detection limit
…lue below an unknown detection limit
…an of blue catfish (I. furcatus) samples collected in two sites in
…ptember 1982.

The sampling program would provide synoptic data for measuring the presence of toxic constituents in the freshwater receiving area. About 3 years prior to the initiation of freshwater diversion, sampling would be used to define seasonal and climatic variations at strategic locations, including the receiving area. These data combined with available historical data would provide a base condition by which changes in water quality could be assessed. After diversion has begun, and 4 years thereafter, sampling would be performed at the same selected locations. This data would provide the necessary information to assess seasonal and long-term trends in water and sediments. Parameters to be analyzed are presented in Table 7. During this 4-year impact assessment, data would be analyzed to determine any shortcomings or necessary modifications. The sampling program could be modified at any time to improve the efficacy, and, by the conclusion of the study, a decision would be made as to the direction and nature of further analysis. Tissue sampling would be an integral part of the program.

V. Summary

Impact of the freshwater diversion from the Lake Cataouatche site for the Louisiana Coastal Area proposed project is expected to be minimal on the Bald Eagle. Extensive water quality analysis will be performed to assure the project would not affect the continued existence of this nesting pair and its territory.

Table [illegible]. Water Quality parameters to be analyzed 3 years prior to, and [illegible] after, the initiation of freshwater diversion.

pH	Oil and Grease
Turbidity	Chemical Oxygen Demand
Fecal Coliform Bacteria	Total Kjeldahl Nitrogen
Total Hardness	Mercury
Total Dissolved Solids	Lead
Total Suspended Solids	Zinc
Ammonia Nitrogen	Chromium
TKN	Cadmium
Chlorophyll a	Copper
Total Manganese	Iron
Total Chromium	Manganese
Total Cadmium	Nickel
Total Copper	Aldrin
Total Mercury	Dieldrin
Total Nickel	Chlordane
Total Lead	Endrin
Total Zinc	Heptachlor
Aldrin	Lindane
Dieldrin	DDT and metabolites
DDT and metabolities	Toxaphene
Endrin	PCB
Chlordane	Redox Potential
Heptachlor	pH
Toxaphene	Total Solids
Lindane	Total Volatile Solids
PCB	

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United States Department of the Interior
FISH AND WILDLIFE SERVICE
JACKSON MALL OFFICE CENTER
300 WOODROW WILSON AVENUE, SUITE 3185
JACKSON, MISSISSIPPI 39213

March 2, 1983

Cletis R. Wagahoff
artment of the Army
Orleans District, Corps of Engineers
t Office Box 60267
Orleans, Louisiana 70160

r Mr. Wagahoff:

s refers to your letter of January 28, 1983, which transmitted a supple-
tal biological assessment on relocating the Barataria Basin freshwater
ersion site from Lac Des Allemands to Lake Cataouatche. The original
logical assessment was filed on July 14, 1981 (Log No. 4-3-80-007).

review of the supplemental assessment has revealed that it fails to
sider the impact of increased water levels (resulting from the project)
n bald eagle nesting habitat. We request that the assessment be revised
discuss (1) the depth and timing of water levels to be maintained by
te and/or parish officials, (2) the impact of these water levels upon
living trees of the wooded swamp at various elevations along the ridge
which the eagles currently nest, and (3) the impact of these water levels
n regeneration of the wooded swamp in which the eagles nest.

r cooperation in this matter has been appreciated.

Sincerely,

Dennis B. Jordan

Dennis B. Jordan
Field Supervisor
Endangered Species Field Office

RD, FWS, Atlanta, GA (AFA/SE)
ES, FWS, Lafayette, LA
Department of Wildlife & Fisheries
New Orleans, LA
D, FWS, Washington, D.C. (AFA/OES)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
JACKSON MALL OFFICE CENTER
300 WOODROW WILSON AVENUE, SUITE 3185
JACKSON, MISSISSIPPI 39213

March 28, 1983

Colonel Robert C. Lee
District Engineer
New Orleans District, Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160

Dear Colonel Lee:

This refers to a January 28, 1983, letter from Mr. Cletis Wagahoff of your staff and the attached amended biological assessment on relocating the Barataria Basin freshwater diversion site from Lac des Allemands to Lake Cataouatche (Log no. 4-3-80-007). By letter dated March 2, 1983, we requested additional information on this project's impacts upon bald eagle habitat. Following a further review of your assessment, we have concluded that this project may affect the endangered bald eagle. This determination is based on statements in your assessment which indicate that: (a) bald eagle populations have suffered reduced reproduction due to pesticide (and certain other toxic chemical) accumulation through their food chain and (b) unacceptable levels of contaminants are sometimes found in the river water which will be diverted over bald eagle feeding and nesting habitat. The purpose of this letter, therefore, is to recommend that formal consultation be initiated and to request additional information needed in preparation of the Biological Opinion.

In order to develop the biological opinion, the following additional information will be required.

(1) A discussion of the without project impacts likely to occur within the proposed levied receiving area due to saltwater intrusion.

(2) A discussion of the impact of the project upon the two nests located immediately south of Lafitte. Will the project reduce salinity levels in the vicinity of these nests? If so, what would be the anticipated effect upon the eagle habitat, including the nest trees? How will the project affect water quality in the vicinity of these nests? Will pollution levels be significantly reduced by the time the diverted water reaches this area?

(3) A detailed discussion of the monitoring program which will be used to assure that the project does not affect the continued existence of this nesting pair and its territory. The assessment emphasizes that extensive water quality analysis will be performed to assure the project would not affect the continued existence of this nesting pair and its territory. It also states that tissue sampling would be an integral part of the sampling program but does not discuss this further. We recognize that water quality analysis will be important in monitoring the general environmental affects of the project. We do not believe, however, that

water quality analysis will serve as an adequate monitoring system for contaminants which threaten bald eagles. In order to monitor the bioaccumulation of contaminants in the bald eagles food chain, it will be necessary to conduct a toxic materials scan of bald eagle prey items at periodic intervals. This monitoring scheme should be worked out and agreed upon in the proposed consultation. The following is our proposed sampling scheme.

Select four sampling stations within the levied receiving area. Collect five individuals each of mottled ducks, channel catfish, and nutria from each station. Sampling would be conducted in the fall and spring for 3 years prior to the initiation of freshwater diversion and for 4 years after initiation of diversion. After completion of the 4 year data gathering period, sampling would continue on a periodic basis to be determined in this consultation. As a minimum, we recommend that such sampling be conducted every three years until the end of the project life, or until the bald eagle no longer utilizes the area. We recognize that the final determination of the frequency of this sampling should be based on our mutual review of the 7 years sampling data. We would appreciate your comments on this.

A discussion of the action to be taken if contaminant levels begin to rise to a point likely to affect eagle reproduction. An agreement should be reached that if contaminant levels appear to be reaching such levels, consultation will be re-initiated to consider the impact of the contamination upon the status of the eagle population and the appropriate course of action to be taken to protect the eagles (to include halting the diversion until the threat is ameliorated and/or moving the fledgling eagles out of the area).

A detailed discussion of the water management scheme to be used within the levied receiving area. The assessment does not discuss the season of the year in which diversion will take place, the management of the water levels within the levied receiving area during diversion and non-diversion periods, or the frequency of diversion. It also does not discuss the impact of these conditions upon the existing mature trees and their regeneration at various elevations along the ridge on which the eagles currently nest. This information will be needed to allow the assessment of the impact of the project upon the eagles' nesting habitat.

cooperation in this matter is appreciated. We suggest that a mutual ement be reached that the 90-day formal consultation period be initiated he date that you provide our office the above information.

Sincerely yours,

Dennis B. Jordan

Dennis B. Jordan
Field Supervisor
Jackson Endangered Species Office

D, FWS, Washington, D.C. (AFA/OES)
RD, FWS, Atlanta, GA (AFA/SE)
ES, FWS, Lafayette, LA
Department of Wildlife and Fisheries
New Orleans, LA

erflow area or pass through the weirs into Lake Cataouatche. It is t anticipated that significant sediments would be deposited into the oded wetlands to the west of the diversion channel. These areas are higher elevation, and, due to this gradient, it is unlikely that diments would accumulate. Most of the dominant tree species in the ea can tolerate greater siltation depths than would occur with project plementation.

a study of the lower White River, Arkansas valley, Bedinger (1971) und baldcypress trees were present in an area flooded 29-33% of the me. This flooding occurred in late fall/early winter to mid/late ring. Vegetation in Lake Chicot, Louisiana, was studied by Penfound 949) in 1943-1947 and Eggler and Moore (1961) in 1960. Chicot Bayou s impounded in 1942, and a fall/winter draw-down of 4-5 feet nducted. With the lake at spillway level, vegetation in water 0-2 et deep and vegetation in water 2-11 feet deep was examined. In the allow peripheral area, there was a 10% decline in cypress density ring the first 4 years; however, in 18 years, there was a 383% crease. In the deeper water area, cypress was the most abundant tree 1943, and continues as such. In this area, the mortality rate during e first 4 years was 3%; however, in 18 years, it was 50%. Many of ose living trees remaining had dead tips. Demaree (1932) noted large, ture cypress trees in water to a depth of 20 feet died; those bmerged 7 to 10 feet were stressed with dead tops, and those 1.5 to 7 et thrived. Although low-water levels do not impact the trees, it es affect regeneration. Moist soil is needed for successful rmination of cypress seeds. Damaree (1932) reported cypress seeds ored in water for 30 months grew when planted; Applequiest (1959) ported reduced viability after a year. Seedlings about a year old ed after 10 days of submergence and seedlings 2 to 3 years old would t survive a month of submergence. Seedlings half-submerged for 6 eks survived. The observations of Eggler and Moore are in agreement th these findings. From the aforementioned data, it is evident that

water to the basin by way of the marshes above Lake Cataouatche. The project is designed to maintain the optimal salinity regime for the driest year which would occur in an average ten-year rainfall cycle. During this year, up to 10,650 cfs would be diverted from January through May, with an average flow of 7,500 cfs. During six years, an average of 4,500 cfs would be necessary, and in three out of ten years, no diversion would be required.

Ponding water could adversely impact certain vegetative species. It is believed that the critical stress suffered by plants is a result of the oxygen depletion in the flooded soil, but also is related to the characteristics of the flooding regime, size and age of the plant, type of substrate, anatomical structures, and physiological processes. According to Klimas et al. (1981) swamp and low-ridge species such as water hickory, pecan, buttonbush, swamp privet, green ash, water locust, deciduous holly, tupelogum, water elm, overcup oak, Nuttall oak, black willow, and baldcypress, are very tolerant and can survive deep prolonged flooding for more than one year. Species which grow on low ridges such as red maple, hackberry, persimmon, and sweetgum are described as tolerant and are able to survive flooding for one growing season. Other species found on the higher ridges in the area, such as honey locust, willow oak, live oak, and American elm, are only somewhat tolerant, being able to survive flooding for about 30 consecutive days. Many of the trees and shrubs in the area, particularly those in the swamps between the ridges and on the lower portions of the rapidly subsiding ridges, would not suffer significant adverse impacts.

At least 60 percent of the river sediment would be deposited into the retention area. Over the 50-year project life, it is estimated that a 4 square mile delta varying from 1 to 4 feet thick would be formed by the deposition of sand and heavy silts. During diversions, the predominant flow would be in a southerly direction toward Lake Cataouatche. Some of the finer sediments would be deposited into the lower end of the

[illegible] ridges and wooded areas. The loss of wooded swamp would accelerate as saltwater intrusion exceeds the tolerance levels of the trees.

A major factor contributing to baldcypress mortality in the Barataria Basin has been the encroachment of salt water. The impact of salt water is a function of the concentration and duration of exposure. A study by Wicker, et al. (1981) in Tangipahoa Parish, found the marsh-shrub zone experienced water salinities greater than 1 ppt 38% of the time. A stressed cypress swamp was exposed to 1 ppt less then 2% of the time and non-stressed swamp less than 1% of the time. A comparison of the stems per acre of baldcypress and the inundation by waters greater than 0, 1, 2, and 3 ppt indicated the decrease in baldcypress corresponded to a frequency of inundation with water having salinities greater than 2 ppt. Chabreck (1972) reported a mean water salinity of 1.90 $\pm$ 0.7 ppt for five plots located at the swamp-marsh interface; an ecotone which would be the tolerance limit for baldcypress. The results of these two studies suggest the upper tolerance limit of baldcypress is between 1.8 and 2.1 ppt.

In order for salt water to stress cypress trees, it must first cause an increase in soil salinity. This increase is primarly a function of salt concentration and duration of exposure; however, soil composition, rate of evapotranspiration, and amount of flushing play a role. Wicker, et al. (1981) examined the relationship between soil salinity and cypress abundance. They found both the basal area and number of stems per acre were proportional to soil pore salinities (chlorides). The authors concluded that major impacts occurred when soil pore salinities reached about 1.0 ppt. From their data, it appears as though soil salinities of less then 0.5 ppt are preferable. Without the project, these soil salinities would be exceeded within a few years.

A control structure would be used to regulate water releases, and a 2.3-mile channel through St. Charles Parish would be used to divert

Figure 2. Chloride (mg/l) and salinity (ppt) changes in Lake Salvador, Louisiana, from 1978 - 1980. Data from EPA Storet.

```
294326090151520                                                          STORET System
29 43 26.0 090 15 15.0  2
CENTER OF LAKE SALVADOR (CE99216)
22089 LOUISIANA        ST CHARLES

112WRD   08090301000           /TYPA/AMBNT/STREAM
       780311      DEPTH    0
 INDEX
 MILES

               PARAMETER                     NOBS    AVE     MAX     MIN  BEG-DATE  END-DATE
          940 CHLORIDE    TOTAL     MG/L      25     397     1100     48  78/01/23  81/01/20
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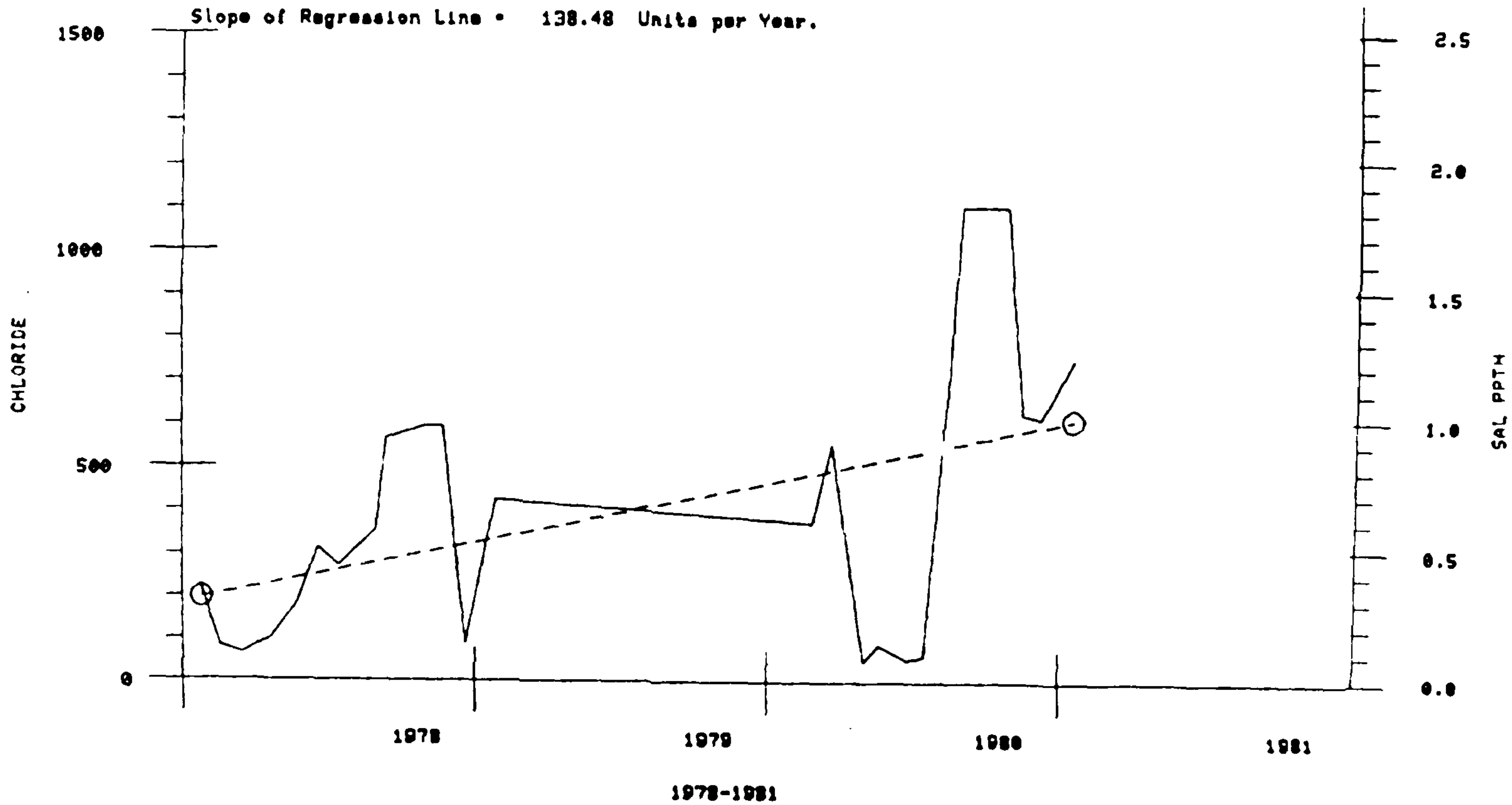


III. Impacts

LAKE CATAOUATCHE BALD EAGLE NEST

The Bald Eagle Amendment #1 specifically addressed this pair of eagles. Additional information on potential impacts on the eagle tree by inundation and saltwater intrusion, and to the nesting pair by water quality is presented here to complement the first admendment.

The Davis Pond site incorporates a 7,425-acre overflow area above Lake Cataouatche. The overflow area is predominantly a floating vegetative type composed of maidencane, bulltongue, spikerush, beggarticks, water primrose, and cattail with a baldcypress-tupelogum hardwood community on a partially submerged ridge to the west. This pair nests in the top of a tall cypress tree on the swamp forest edge overlooking open-marsh.

As mentioned in the Introduction, Section I, there has been a rapid increase in more salt-tolerent species in much of the Barataria Basin. In the mid-40's, the entire area surrounding Lake Cataouatche was composed of fresh-marsh species; however, by the mid-70's the southern shore was an intermediate type. The marshes north of the lake, and adjacent to the nest, are still fresh. An examination of the 25,000 acres in the Lake Cataouatche quadrangle from 1956 to 1978 (Table 4; [illegible] #1) indicates an approximate 60% loss of fresh marsh. About [illegible] loss is due to conversion of fresh to intermediate marsh as a result of saltwater intrusion, and the remainder lost to estuarine open water because of erosion and subsidence. There was a 10% loss of wooded swamp. Salinity information from this area is sparse. Limited available data from the STORET system indicate a gradual increase in Lake Salvador salinities from 1978 to 1981 (Fig. 2). Large portions of the finger ridges in the area have subsided and are flooded much of the time. The refuge manager for the Salvador Wildlife Management Area has worked in the area for 14 years and has noted the dramatic changes in

Table 4. The percentage of prey items collected from the North Lafitte Bald Eagle nest in 1979 (Dugoni, 1980).

PREY	PERCENTAGE
BIRDS (%=33; N=5)	
Canvasback	7
American Coot	20
Common Gallinule	7
FISH (%=53; N=8)	
Sea Catfish	20
Freshwater Catfish	33
MAMMALS (%=7; N=1)	
Swamp Rabbit	7
REPTILES (%=7; N=1)	
Mud Turtle	7

Table 5. Relative percentage of habitats surrounding the Lafitte Bald Eagle nests as determined by Dugoni (1980).

RADII	HABITAT							
	Lakes	Marsh Ponds	Bayous	Swamp	Marsh	Pipeline Canals	Pipeline rights-of-way	Development
				NORTH LAFITTE NEST				
1 Mile (1.6 km)	19.4	2.4	5.0	21.2	49.4	0.8	0.0	1.8
2 Mile (3.2 km)	37.5	3.5	3.1	11.0	33.0	0.9	0.6	10.3
3 Mile (4.8 km)	31.7	3.9	2.5	5.6	41.1	1.9	0.3	13.1
				SOUTH LAFITTE NEST				
1 Mile (1.6 km)	33.3	6.5	1.2	17.2	40.5	1.0	0.0	0.1
2 Mile (3.2 km)	24.8	3.7	3.1	8.1	54.4	1.5	2.1	2.2
3 Mile	21.8	5.8	2.3	6.4	58.1	2.4	1.4	1.7

Table 2. Reproductive data on the Lafitte Bald Eagle nests in the vicinity of the Louisiana Coastal Area study.

YEAR	SOURCE	OCCUPIED[a]		ACTIVE[b]		SUCCESS[c]	
		North	South	North	South	North	South
1974-75	Dubuc [d]	Y				0	1
1975-76	Dubuc[d]	Y				2	1
1976-77	Dubuc[d]	Y				1	2
1977-78	Dugoni, 1980[e]	Y	Y	2	2	0	1
1978-79	Dugoni, 1980[e]	Y	Y	2	2	1	0
1979-80	Dugoni, 1980[e]	Y	Y	2	3[f]	2	1
1980-81	Dubuc[d]	Y	Y	2	?	2	?
1981-82	Dubuc[d]	Y	Y	?	0	1	0
1982-83	Dubuc[d]	Y	X	2	-	?	-

[a] Adults at the nest; Y=Yes, N=No, X=destroyed

[b] Number of eggs

[c] Number of fledglings

[d] Letters to USFWS and personal communications with the USCEC

[e] Dugoni, J.A. 1980. Habitat utilization, food habits, and productivity of nesting Southern Bald Eagles. M.S. thesis, LSU, 151pp.

[f] Portion of nest destroyed in early 1980, renested.

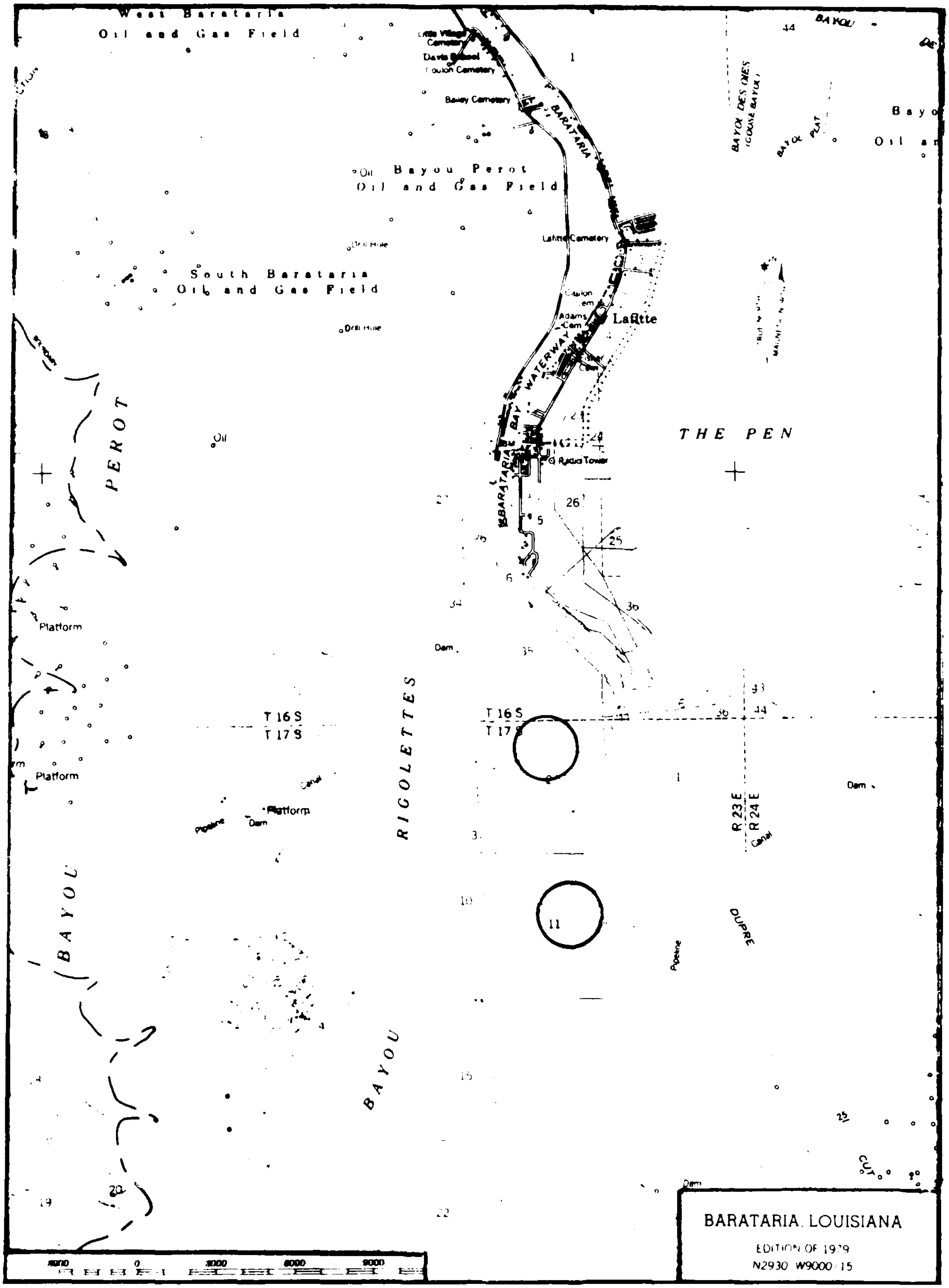


Figure 1. Location of the North and South Lafitte Bald Eagle nests.

II. Present Conditions

The foraging areas, behavior, prey items, nesting sites, and surrounding habitat types of the Lake Cataouatche Bald Eagle nesting site were discussed in the first admendment (#1). The two nests in the vicinity of Lafitte were addressed in the original assessment, and additional data on these eagles is provided in this document.

The North and South Lafitte Bald Eagle nests (#2 and #3 of Dugoni) are within the study area, located about 3 to 5 miles south of Lafitte, LA., between Bayou Rigolettes and Barataria Bay Waterway (Fig. 1). The nests have been occupied since, at the minimum, the 1974-75 breeding season. Each pair has been relatively successful, producing 0 to 2 young per nest. The southern nest has had several recent failures, and was destroyed in 1983. Reproductive data on these birds are in Table 2.

The northern and southern nests are both in dead live oak trees about 60 feet (18 m) and 85 feet (26m) above the ground, respectively. The nesting sites are in a mixed deciduous type habitat on a ridge overlooking an extensive area of intermediate/brackish marshes. Vegetation typical of the ridge includes live oak, water oak, American elm, red maple, and sweetgum; plants common to the marsh include wiregrass, bulltongue, bullwhip, sawgrass, leafy threesquare and three-cornered grass. The area surrounding the nests consists predominantly of lakes, bayous, swamps, and marsh. The habitats within one, two, and three miles of the nests are presented in Table 3.

A limited sample of prey collected from the northern nest by Dugoni in 1979 (Table 4) indicates about half the birds diet was catfish; a third, birds; and the remainder, mammals and reptiles. Because the nests are close, it could be assumed the southern nesting pair would utilize similar prey items.

Table 1. Water salinity (ppt) and vegetative type for Hydrologic Unit V as determined by Chabreck (1972).

Vegetative Type	**Water Salinity**		
	Mean	Standard Deviation	Range
Saline	15.8	3.8	6.3-21.9
Brackish	9.7	5.1	3.3-28.1
Intermediate	5.4	2.7	2.7- 8.0
Fresh	1.8	1.2	0.1- 4.5

0.5 feet per second (fps). Average velocity in Lake Cataouatche would be about 0.1 fps, although velocities would be greater adjacent to the weirs. By the time the water reaches Lake Salvador, velocity would be only about 0.06 fps. The potential benefits of the proposed project would be decreased saltwater intrusion, increased wetland productivity, and reduced land loss, while adverse impacts would include the introduction of pollutants and cooler water, and loss of 305 acres of wetland to construct the channel.

The average land loss rate for coastal Louisiana has increased from 16.5 to over 39 square miles per year with a range of 0 to 4 acres/square mile/year. Between the mid-1950's and 1978, the estimated marsh loss rate for the entire Barataria Basin was 7.7 square miles per year (Wicker, 1980). The loss is the result of compaction, subsidence, erosion, and saltwater intrusion. Land loss has been accelerated by construction of numerous canals for navigation, drainage, and mineral exploration. Between the period 1940-1970, a total of 71.2 square miles of canals was dredged in Barataria Basin, and this dredging has resulted in the lengthening of the tidal shoreline by 1,557 miles (Becker, 1972). In a study in Barataria Basin, Chabreck (1972) examined the plant species composition of the saline, brackish, intermediate, and fresh marshes, and determined the salinities for each (Table 1). Based on work of Chabreck and Linscombe (1978), a 17% net increase (207 mi^2) of more saline type vegetation occurred within the Barataria Bay Basin (Hydrologic Unit IV) during the 10-year period from 1968 to 1978.

BIOLOGICAL ASSESSMENT AMENDMENT #2
THREATENED AND ENDANGERED SPECIES

LOUISIANA COASTAL AREA STUDY, LOUISIANA

Freshwater Diversion to Barataria Basin

I. Introduction

In a letter dated March 28, 1983, the U. S. Fish and Wildlife Service (FWS) initiated formal consultation and requested additional information to aid in their preparation of a Biological Opinion assessing the potential impacts of the Louisiana Coastal Area (LCA) study on the Bald Eagle. This amendment complements the original Biological Assessment filed with the FWS in 1980 (Log No. 4-3-80-007) and a Biological Assessment Amendment (#1) filed in January 1983. The latter assessment examined the impacts of relocating the Barataria Basin diversion site of the LCA study from Lac des Allemands to Lake Cataouatche.

The Barataria Basin aspect of the LCA study examines the potential for freshwater introduction from the Mississippi River into the Barataria Basin to maintain the 15 parts per thousand (ppt) isohaline at the "Ford Line." To achieve this goal, Mississippi River water would be diverted from January through May on a flexible schedule. Based on a typical 10-year rainfall cycle, an average of 7,500 cfs would be diverted once every 10 years, 4,500 cfs in six years, and no diversions would be required in the remaining three years. During diversion, water would flow through the overflow area at a depth of 1 to 2 feet, with water being deeper over the lower marsh areas and shallow, or absent, on the higher portions of the ridges. Duration of the ponding would vary depending on the diversion necessary. At peak flow, water would be retained in this area for about one day; however, with reduced flows, retention time would increase. Flow over this area would be controlled by a system of five weirs located along the northern shore of Lake Cataouatche. Velocity in the overflow area would be at a rate of about

DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P.O. BOX 60267
NEW ORLEANS, LOUISIANA 70160

REPLY TO
ATTENTION OF

June 28, 1984

Planning Division
Environmental Analysis Branch

Mr. Dennis B. Jordan
U. S. Fish and Wildlife Service
Jackson Mall Office Center
300 Woodrow Wilson Avenue, Suite 3185
Jackson, Mississippi 39213

Dear Mr. Jordan:

The enclosed Biological Assessment Amendment (#2) complements the Biological Assessment filed with your agency on July 14, 1981, (Log. No. 4-3-80-007) and a Biological Assessment Amendment (#1) transmitted to you on January 28, 1983. This document provides the additional information requested in your March 28, 1983, letter to aid in preparation of Biological Opinion assessing the potential impacts of the Louisiana Coastal Area study on Bald Eagles.

Please feel free to contact Mr. E. Scott Clark of this office, telephone (504) 838-2521, if you require further information.

Sincerely,

Cletis R. Wagahoff
Chief, Planning Division

Enclosures

Copy Furnished: w/encls.

Mr. Dave Fruge
Ecological Services
U. S. Fish and Wildlife Service
P. O. Box 4305
Lafayette, Louisiana 70502

raising of water levels in the retention area would have a minimal impact on cypress regeneration, growth, and mortality. Because of present subsidence and erosion, the lower ridge containing the nest is currently under water, and regeneration of new cypress trees is impossible. The area is high enough; however, there would be mature trees with or without the project. In years of high diversion flows, cypress seeds would be dispersed further up the ridge; and during years of no diversion, they would be distributed as with the present regimes. During these high diversion periods, some seedlings would be submerged and lost; however, there would be sufficient years of low flow or no flow to allow the establishment of seedlings. To enhance cypress regeneration, reduced water levels would need to be maintained for several consecutive seasons to allow the seedlings an opportunity to grow to a height which would prevent total submergence.

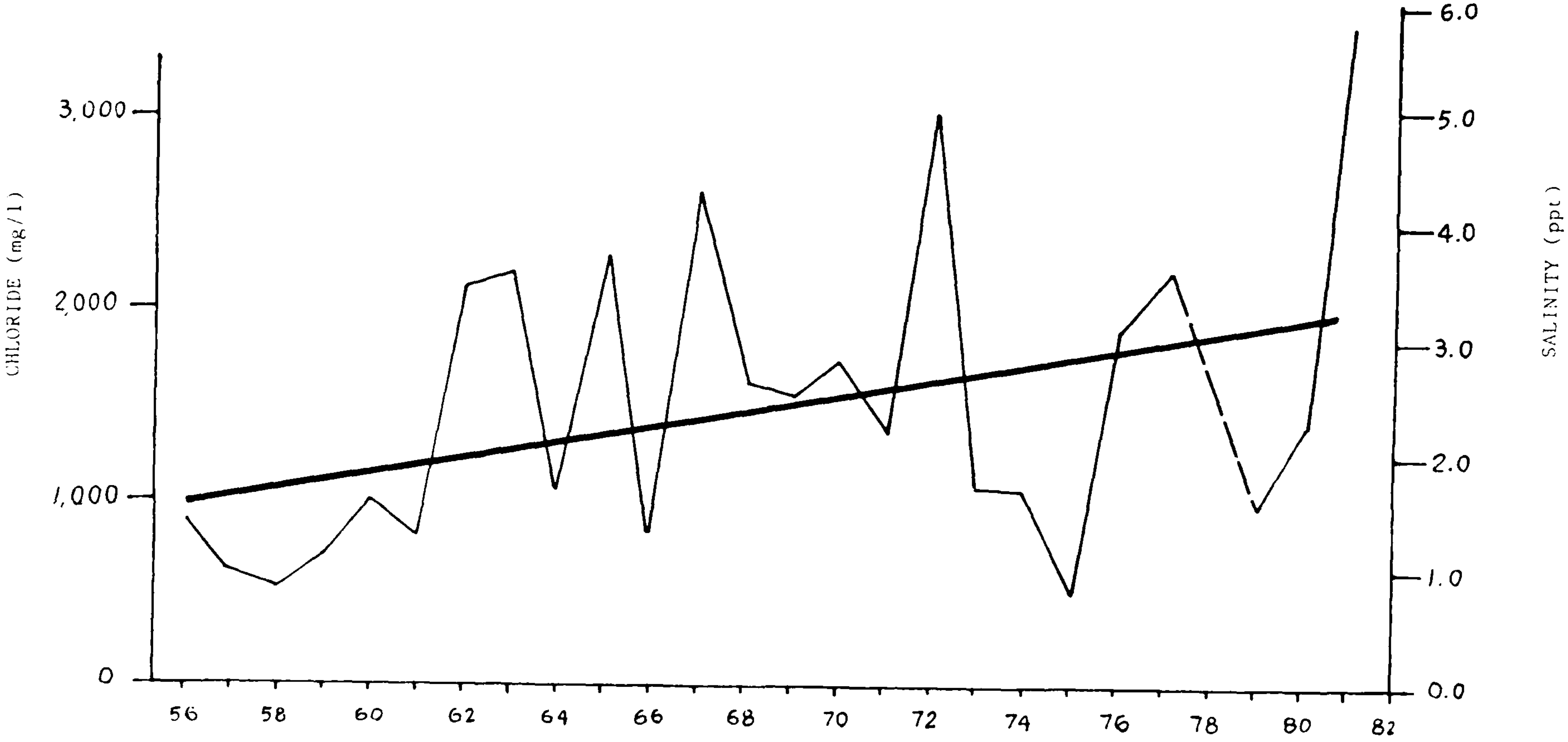
Because weirs would be installed to raise water levels during diversion, great potential exists for management of the overflow area for wildlife, primarily waterfowl, by the Salvador Wildlife Management Area personnel. The continuous retention of water levels artifically high would impact regeneration, and could impact those trees already present in deeper water. The latter is not likely to be significant because most of the area is shallow as evidenced by the extensive marshes surrounding the ridges. The management area personnel have indicated the ponding site would not be managed to the detriment of the eagles. If water levels were managed on a fixed schedule and cypress trees impacted, the planting of several year old trees could be a viable alternative.

LAFITTE BALD EAGLE NESTS

Although saltwater intrusion into the Lafitte Bald Eagle nesting area would be reduced, this probably would not be sufficient, nor of a long enough duration, to aid the re-establishment of a fresher type vegetation. The diversion of fresh water would have no effect on the water levels surrounding the nest. The vegetation in the nest vicinity has gradually become a more saline type, especially with the construction of the Barataria Bay Waterway. Salinity increases at Lafitte are displayed in Figure 3.

The increased concentrations of pollutants in the marshes surrounding the nest would be minimal. These nests are not in the main diversion route, and flows through Bayou Rigolettes and Bayou Barataria would tend to restrict the flow of diverted water in this area. As the water flows over the marshes, it would gradually be cleansed of pollutants. Windom (1977) noted nutrients and heavy metals were removed during overland flow through salt marshes. The important mechanism appears to be the accumulation of pollutants on particles which are inertly bound and subsequently deposited in the marsh sediments.

Figure 3. Chloride (mg/l) and salinity (ppt) changes in Bayou Barataria at Lafitte, Louisiana, from 1956 - 1981. Data from EPA Storet.



IV. Sampling

Much of the Bald Eagle decline has been attributed to the accumulation of toxic materials, especially pesticides, through the food chain. Most of these materials have not killed the birds outright, but have resulted in eggshell thinning. The release of Mississippi River water would introduce undesirable pollutants into the receiving area marsh, and these pollutants would be incorporated into the food chain and bioaccumulated. Pollutant levels of the Mississippi River water for selected toxic materials are presented in Table 5 of Amendment #1. The concentrations of heavy metals and pesticides in Mississippi River fish, primarily catfish, are presented in Table 6 of the same document. From an examination of these data, it appears the pollutants would not result in immediate and irreversible harm. Unfortunately, the long-term effects of exposure to low levels of toxic materials is unknown. For this reason, a water and tissue sampling program would be performed in addition to that conducted by local municipalities and state and Federal agencies. The water quality aspect of the program was discussed in the first amendment, and the parameters to be analyzed in Table 7 of the same document.

The tissue sampling program would be similar to that suggested by the US Fish and Wildlife Service. Sampling would be conducted in the spring and fall at 4 stations within the receiving area, with five individuals each of catfish and nutria being collected at each station. It would be desirable to collect 5 avian species per station; however, this would be difficult. Because most of the birds taken by the eagles are migrating waterfowl, sampling these birds would not indicate local pollution problems. The resident mottled duck population is not sufficient to withstand this sampling program. One alternative would be to collect a different species and/or reduce the collecting frequency. Collecting a sample of five mottled ducks each fall, and five gallinules each spring, from the receiving area is proposed. The tissue analysis would be done on the whole animal, and each species from a sampling station would be

pooled prior to analysis. Analysis would be done for EPA priority pollutants within the heavy metal, pesticide, and PCB groups. This analysis generally examines 13 metals, 17 pesticides, and a few PCB's. The following toxic materials known to impact eagles would be included in the above analysis: heavy metals-cadmium, copper, lead, nickel, mercury, and zinc; the pesticides-aldrin, chlordane, DDT, DDE, dieldrin, endrin, heptachlor; and PCB's. A screening analysis would be performed on combined samples from each station for each species to determine any pollutant not specifically examined. The lab tests would be performed by the U. S. Fish and Wildlife Service's lab or a lab approved by them. About $600 dollars would be required for the analysis of the combined tissue samples of each species per station. Approximately $12,000 per year would be necessary for this monitoring.

If project operation results in contaminants increasing to a level that appears to be affecting eagle reproduction, then consultation would be re-initiated. Should it be determined the project operation is impacting the eagles, corrective action would be necessary. These actions could be as simple as a temporary closure of the structure or as elaborate as re-locating the pair. Pollutant levels significant enough to directly impact the adult or juvenile birds probably would be of such severity to public health that the structure would be closed immediately. It is the low levels that are of particular concern, because they could stress the adults or affect eagle reproduction. Levels of toxic material sufficient to reduce eagle productivity also would be impacting the reproductive output of many other species. For this reason, barring some unforseen circumstances, the structure would be closed until the source is located and the release of toxic material is halted.

Although modification of the operational schedule could be used to reduce pollutant loads, it is possible that a situation could arise where only top carnivores, like eagles, would be affected. The total shutdown of the facility based solely on the potential detrimental

impacts to eagle reproduction is unlikely. One possible solution would be to provide an alternative "clean" food source. An area could be managed for fish, primarily catfish, and waterfowl. Also, food could be provided at a feeding station and "scavenged" by the pair. Under extreme conditions, young could be transplanted or the chicks captive-reared.

V. Conclusion

The impact of diverting Mississippi River water through Lake Cataouatche and into the Barataria Basin is expected to have minimal effects on the Bald Eagle. Reproductive parameters of the pair will continue to be monitored, and extensive water and tissue analyses will be performed. If pollutants reached levels that could affect the continued existence of these birds, then the structure would be closed or a "clean" food source provided.

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July 24, 1984

Colonel Robert C. Lee
District Engineer
New Orleans District, Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160

Dear Colonel Lee:

This letter refers to the ongoing endangered species consultation on the effects of the Louisiana Coastal Area, Freshwater Diversion to Barataria Basin Project upon the endangered bald eagle (log number 4-3-81-007). Our initial consultation efforts indicate that this project will likely have positive impacts on the vitality of the freshwater marshes and swamps in the project area. These impacts include benefits to the bald eagle nesting habitat.

Unfortunately, the project also poses a potential risk for the bald eagle as pollutants may be introduced to the eagles feeding habitat by diversion of Mississippi River water into the area. Your Biological Assessment Amendment No. 2 (p.17) states that the release of Mississippi River water would introduce undesirable pollutants into the receiving area marsh and these pollutants would be incorporated into the food chain and bioaccumulated. The amendment recognizes that much of the bald eagle decline has been attributed to such accumulation of toxic materials . . . through the food chain. This has not typically resulted in direct mortality of adult eagles but rather reduced nest success due to egg shell thinning and death of embryos. It is not possible at this time to know the identity, concentration, or bioaccumulation characteristics of all the compounds which will be present in the river water during the fifty-year diversion period. Therefore, it is not possible to fully assess the likely impacts of the diversion upon bald eagle nest success.

As your Biological Assessment states, the Barataria Basin hosts at least three bald eagle nesting territories. Two of these nests are located just south of Lafitte more than twenty-five miles from the Davis Pond diversion site. Your assessment states that the increased concentrations of pollutants in the marshes surrounding these nests would be minimal due to the location of the nest territories and the removal of toxic materials by the marshes. These nests have produced at least 14 of the 134 bald eagles known to have fledged in Louisiana between 1974 and 1984.

The nest territory located on the Salvedor Game Management area and within the 7,425-acre overflow area is of much greater concern due to its proximity to the Davis Pond diversion site. This nest has been occupied for at least 30 years and has produced at least 9 of the 134 bald eagles fledged in Louisiana between 1974 and 1984.

In view of the significance of these nests to the recovery of the Louisiana population of the bald eagle, it is the opinion of this office that the New Orleans District, Corps of Engineers should incorporate a commitment into the project plans to compensate for any future loss of bald eagle reproductive success within the project area due to the bioaccumulation of toxic materials. The commitment to compensate should include a list of actions one or more of which will be employed in this effort and should recognize that final selection of the action(s) to be employed will be determined by re-initiation of consultation at such time as bioaccumulation of toxic materials is recognized to be affecting nest success. (The detailed toxic materials sampling scheme which is discussed in Amendment 2 should allow association of reproductive declines with increases of toxic substances in the eagles food chain.) Actions to be included under the commitment should include:

(1) temporary closure of the diversion structure to allow identified pollutants to pass before re-initiation of diversion.

(2) supplemental feeding to provide the pair a clean food source.

(3) capture of the adult pair, and captive propagation of their young at a facility such as the Patuxent Wildlife Research Center and fostering (or hacking) of the young back into appropriate habitat in southern Louisiana.

(4) fostering or hacking of young bald eagles in southern Louisiana from sources other than the pair(s) which nested in the project area.

It is likely that measures 1 and 2 would be attempted initially and measures 3 and 4 would be employed if 1 and 2 failed to restore the pre-diversion nest success of the pair. It should be recognized that measures 3 and 4 could cost as much as $15,000 per year in current dollars and would have to continue for at least ten years to insure a reasonable chance of success.

I recommend that this commitment be entered into the project plans and that you advise this office of your intention to do so. This action would remove the risk posed by this project to the Louisiana bald eagle population and would greatly facilitate the preparation of a favorable biological opinion.

e cooperation of your staff in this effort has been appreciated. If you sh to discuss this matter further with a member of my staff, please ntact Mr. Fred Bagley (601/960-4900).

Sincerely,

James Stewart

for Dennis B. Jordan
Field Supervisor
Endangered Species Field Office

: Regional Director, FWS, Atlanta, GA (AFA/SE)
Department of Wildlife & Fisheries, New Orleans, LA
ES, FWS, Lafayette, LA

DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT CORPS OF ENGINEERS
P.O. BOX 60267
NEW ORLEANS, LOUISIANA 70160
August 28, 1984

REPLY TO
ATTENTION OF

Planning Division
Environmental Analysis Branch

Mr. Dennis B. Jordan
U. S. Fish and Wildlife Service
Jackson Mall Office Center
300 Woodrow Wilson Avenue, Suite 3185
Jackson, Mississippi 39213

Dear Mr. Jordan:

Reference is made to your July 24, 1984 letter and several ensuing telephone conversations with Mr. Fred Bagley of your office concerning the ongoing endangered species consultation on the potential effects of the Louisiana Coastal Area, Freshwater Diversion to Barataria Basin project on the endangered bald eagle (log number 4-3-81-007). In that letter, you acknowledged that the proposed project would have positive impacts on the vitality of the fresh marsh and swamps in the area and would also benefit bald eagle nesting habitat. However, you also expressed concern over the potential impacts of pollutants introduced into the eagles' feeding habitat by diversion of Mississippi River water into the area. You indicated that the nesting territory located on the Salvador Wildlife Management Area and within the proposed 7,425-acre overflow area is of primary concern due to its proximity to the diversion site. The main concern is that bioaccumulation of toxic substances could lead to reduced nesting success.

In view of the significance of this nest to the recovery of the Louisiana population of the bald eagle, it is the opinion of your office that the New Orleans District (NOD) should incorporate a commitment into the project plans to compensate for any future loss of bald eagle reproductive success in the area due to project-linked bioaccumulation of toxic materials. The commitment to compensate should include a list of actions one or more of which would be employed in this effort. The toxic materials sampling scheme discussed in Biological Assessment Amendment #2 should allow association of reproductive declines with increases of toxic substances in the eagles' food chain. Your office identified the following actions to be included under the commitment:

(1) Temporary closure of the diversion structure to allow identified pollutants to pass before re-initiation of diversion;

(2) Supplemental feeding to provide the pair a clean food source;

,, pture of the adult pair, and captive propagation of their young i l..y such as the Patuxent Wildlife Research Center and fostering ˜king) of the young back into appropriate habitat in southern ina;

i, Fostering or hacking of young bald eagles in southern Louisiana ources other than the pair which nested in the project area.

ased on our analyses and projections, NOD does not anticipate that levels of contaminants would jeopardize the continued reproductive s of the Salvador eagles. However, we acknowledge that it is not e to definitively assess the identity, concentration, and bioaccumu- characteristics of all compounds which would occur in the Mississippi over the 50-year project life. Therefore, it is not possible to fully : the impacts of the diversion on this pair of eagles.

ie to the uncertainty, and your concern regarding this matter, NOD to commit to action (1). In the event of any significant contaminant on the river, the structure would certainly be closed until the threat ssed. This would be done to insure the safety of all organisms in the ng area, including the eagles. In addition, if future monitoring es that unacceptable levels of contaminants as a result of project on are adversely affecting the eagles' nesting success, action (3) or ild be employed for a maximum of 10 years. As you have suggested, nation of which action would be most appropriate would be done i re-initiation of consultation with your office. However, we would emphasize that, if and when a problem arises, it may be a number of n the future. It would not be prudent to limit ourselves to these s, as it is possible that some other action may be deemed more iate by our agencies at that time. As agreed in a conversation with d Bagley on August 13, 1984, action (2) would be eliminated from consideration.

hope that this letter will facilitate preparation of your biological i in time for us to include this correspondence in our final report s scheduled for completion by September 30, 1984.

iank you very much for your continued cooperation in this matter. If e further questions, please contact Mr. Dennis Chew of my staff at 38-2523.

Sincerely,

LTC CE, DDE

for Eugene S. Witherspoon
Colonel, Corps of Engineers
District Engineer

Bayou Fortier (Mile 132.0) - 5,325 cfs

Inlet Channel:	8 acres WS
	12 acres lake
	3 acres island BLH
	7 acres river
	56 acres BLH
Structure:	2.2 acres A
Transition I:	1.1 acres A
Outlet Channel I:	9 acres A
	22 acres BLH
	48 acres A
Bridge:	1.0 acre A
Outlet Channel II:	15 acres BLH
	6 acres A
	213 acres WS
	74 acres FM
	77 acres water (Bayou Fortier)

Bayou Fortier (Mile 132.0) - 3,550 cfs

Inlet Channel:	7 acres WS
	10 acres lake
	3 acres island BLH
	6 acres river
	47 acres BLH
Structure:	2.0 acres A
Transition I:	0.9 acres L
Outlet Channel I:	8 acres lake
	20 acres BLH
	42 acres A
Bridge:	1.0 acre BLH
Outlet Channel II:	11 acres BLH
	4 acres A
	160 acres WS
	40 acres FM
	77 acres water (Bayou Fortier)

Davis Pond (Mile 118.4) - 10,650 cfs

Structure (River to Reach A):	3 acres BLH 3 acres developed
Pumping Station	0.5 acres developed
Reach A (Tailbay to So. Pac. RR):	36 acres A
Reach A (So. Pac. RR to Hwy 90):	21.5 acres BLH

Transition:	0.8 acres P
Structure:	2.7 acres A
Transition:	3.7 acres A (includes about 1 acre WS)
Bridge:	1.0 acres A
Outlet Channel II:	105 acres FM
	231 acres WS

Bayou Fortier (Mile 132.0) - 10,650 cfs

Inlet Channel:	12 acres WS
	17 acres lake
	5 acres island - bottomland hardwoods (BLH)
	10 acres river
	80 acres BLH
Structure:	2.8 acres A
Transition I:	1.4 acres A
Outlet Channel I:	13 acres lake
	31 acres BLH
	67 acres A
Bridge:	1.3 acres A
Transition II:	3.3 acres (50% BLH; 50% A)
Outlet Channel II:	21 acres BLH
	8 acres A
	300 acres WS
	130 acres FM
	77 acres water (Bayou Fortier)

Bayou Fortier (Mile 132.0) - 7,100 cfs

Inlet Channel:	9 acres WS
	13 acres lake
	4 acres island (BLH)
	8 acres river
	62 acres BLH
Structure:	2.4 acres A
Transition:	1.3 acres A
Outlet Channel I:	11 acres lake
	25 acres BLH
	55 acres A
Bridge:	1.1 acres A
Transition II:	2.8 acres BLH
Outlet Channel II:	17 acres BLH
	6 acres A
	237 acres WS
	89 acres FM
	77 acres water (Bayou Fortier)

D.3.4. The following is a description of acreage and habitat for each freshwater diversion site for different magnitudes of flow broken down by reach and diversion route.

Bayou Lasseigne (Mile 140.9) - 10,650 cfs

Inlet Channel:	10 acres pasture (P)
	2 acres borrow pit (BP)
Transition:	1.25 acres (P)
Structure:	3.5 acres agricultural (A)
Outlet Channel I:	64 acres A
Transition:	5.0 acres A - up 1.0 acres wooded swamp (WS)
Bridge:	1.5 acres A
Outlet Channel II:	177 acres fresh marsh (FM)
	388 acres WS

Bayou Lasseigne (Mile 140.9) - 7,100 cfs

Inlet Channel:	7.7 acres P
	1.5 acres BP
Transition:	1.0 acres P
Structure:	3.1 acres A
Outlet Channel I:	53 acres a
Transition:	4.8 acres A (includes about 1.0 acres WS)
Bridge:	1.2 acres A
Outlet Channel II:	154 acres FM
	337 acres WS

Bayou Lasseigne (140.9) - 5,325 cfs

Inlet Channel:	7.0 acres P
	1.3 acres BP
Transition:	0.9 acres P
Structure:	2.9 acres A
Outlet Channel I:	48 acres A
Transition:	4.3 acres A (includes about 1.0 acres WS)
Bridge:	1.1 acres A
Outlet Channel II:	132 acres FM
	288 acres WS

Bayou Lasseigne (Mile 140.9) - 3,550 cfs

Inlet Channel:	6.0 acres P
	0.9 acres BP

TABLE D-3-2

SITE-SPECIFIC IMPACTS OF DIVERSION ROUTE CONSTRUCTION

Diversion Routes and Magnitude of Flow	Habitat Types (Acres)								
	Bottomland Hardwoods	Wooded Swamp	Marsh[1/]	Water	Agriculture	Other	Construction Staging Areas	Total Acres Impacted	Remarks
Bayou Lasseigne (Mile 140.9)									
10,650 cfs	0	389	177 F	2.0	85.2	0	6.0	659.2	Water consists of small borrow pit areas.
7,100 cfs	0	338	154 F	1.5	70.8	0	5.6	569.9	
5,325 cfs	0	289	132 F	1.0	63.0	0	5.4	490.4	
3,550 cfs	0	232	105 F	1.0	55.7	0	5.2	398.9	
Bayou Fortier (Mile 132)									
10,650 cfs	139	312	130 F	117	82.1	0	8.3	788.4	Water consists of portions of two lakes, river, and Bayou Fortier.
7,100 cfs	111	246	89 F	109	65.5	0	7.5	628.0	
5,325 cfs	99	221	74 F	105	60.2	0	7.0	566.2	
3,550 cfs	83	167	40 F	101	51.0	0	6.5	448.5	
Oakville (Mile 70.4)									
5,325 cfs	13	55	85 F	91	0	32.4	3.1	279.5	Water consists of Bayou Concession and Intracoastal Waterway. Other is developed.
3,550 cfs	9	39	58 F	82	0	27.3	2.4	217.7	
Myrtle Grove (Mile 58.7)									
5,325 cfs	20	0	211 B	216	24.1	45.5	3.1	519.7	Water consists of Wilkinson Canal, Bayou McCutchen and estuarine open water. Other is developed and disposal area.
3,550 cfs	16	0	207 B	216	19.3	44.9	2.4	505.6	
Big Mar (Mile 81.5)									
6,600 cfs	22	6	16 I	70	0	10.8	2.3	127.1	Water consists of Big Mar. Other is developed.
Davis Pond (Mile 118.4)	100	112	93 F	215 [2/]	36.0	4.0	7.0	567.0	Water consists of Bayou Verret, borrow canals, and shallow open water. Other is developed.

1/ F = Fresh; I= Intermediate; B=Brackish
2/ 175 acres of shallow open water will be converted to marsh using dredged materials.

TABLE D-3-1

TOTAL DIRECT IMPACTS OF DIVERSION ROUTE CONSTRUCTION

Plans 1-16

Diversion Sites	Flow (cfs)	Bottomland Hardwoods	Wooded Swamp	Marsh	Water	Agriculture 1/	Other	Total Acres Impacted 2/
		Habitat Types						
Big Mar Bayou Fortier Bayou Lasseigne	6,600 7,100 3,550	133	484	210	180	121	11	1,139
Big Mar Bayou Fortier Bayou Lasseigne	6,600 3,550 7,100	105	511	210	172	122	11	1,131
Big Mar Bayou Fortier Bayou Lasseigne	6,600 5,325 5,325	121	516	222	176	123	11	1,169
Big Mar Bayou Fortier	6,600 10,650	161	318	146	187	82	11	905
Big Mar Bayou Lasseigne	6,600 10,650	22	395	193	72	85	11	778
Big Mar Oakville Bayou Fortier	6,600 5,325 5,325	134	282	175	266	60	43	960
Big Mar Oakville Bayou Lasseigne	6,600 5,325 5,325	35	350	233	162	63	43	886
Big Mar Oakville Bayou Fortier	6,600 3,550 7,100	142	291	163	261	66	38	961
Big Mar Oakville Bayou Lasseigne	6,600 3,550 7,100	31	383	228	154	71	38	905
Big Mar Oakville Bayou Fortier Bayou Lasseigne	6,600 3,550 3,550 3,550	114	444	219	254	107	38	1,176
Big Mar Myrtle Grove Bayou Fortier	6,600 5,325 5,325	141	227	301	391	84	56	1,200
Big Mar Myrtle Grove Bayou Lasseigne	6,600 5,325 5,325	42	295	359	287	87	56	1,126
Big Mar Myrtle Grove Bayou Fortier	6,600 3,550 7,100	149	252	312	395	85	56	1,249
Big Mar Myrtle Grove Bayou Lasseigne	6,600 3,550 7,100	38	344	377	288	90	56	1,193
Big Mar Myrtle Grove Bayou Lasseigne Bayou Fortier	6,600 3,550 3,550 3,550	121	405	368	388	126	56	1,464
Big Mar Davis Pond	6,600 10,650	122	118	109	285	36	15	685

1/ Includes cropland and pasture.

2/ Does not include construction staging areas.

Section 3. HABITAT ACREAGE AFFECTED BY CONSTRUCTION OF FRESHWATER DIVERSION ROUTES

D.3.1. This section contains information concerning the acreage that would be affected by construction of the various freshwater diversion routes. All acreages used in this section are based on designs and information contained in Appendix C, Engineering Investigations.

D.3.2. The section is presented in two parts. The first part identifies the methodology used to identify and delineate the acreages involved The second part provides a more detailed analysis of the acreages and habitats. The information presented in this section is used in evaluating and assessing the various alternatives in plan formulation and provides a basis for the impact analysis presented in the Environmental Impact Statement.

METHODOLOGY USED TO DETERMINE HABITAT ACREAGE AFFECTED BY CONSTRUCTION OF THE DIVERSION ROUTES

D.3.3. In order to determine impacts due to direct construction of the various freshwater diversion routes it was necessary to identify the acreages and quantify the habitat types that would be altered. The rights-of-way necessary for each site for various magnitudes of diversion were drawn on 1:24,000 US Geological Survey quandrangle maps based on information contained in Appendix C, Engineering Investigations. The habitat types and acreages of each habitat type were determined from analysis of the quandrangle maps, 1978 high altitude infrared photos, and US Fish and Wildlife Service habitat maps. Field trips were taken to each site to supplement and confirm the impact analyses. The results of these analyses are presented in tables D-3-1 and D-3-2.

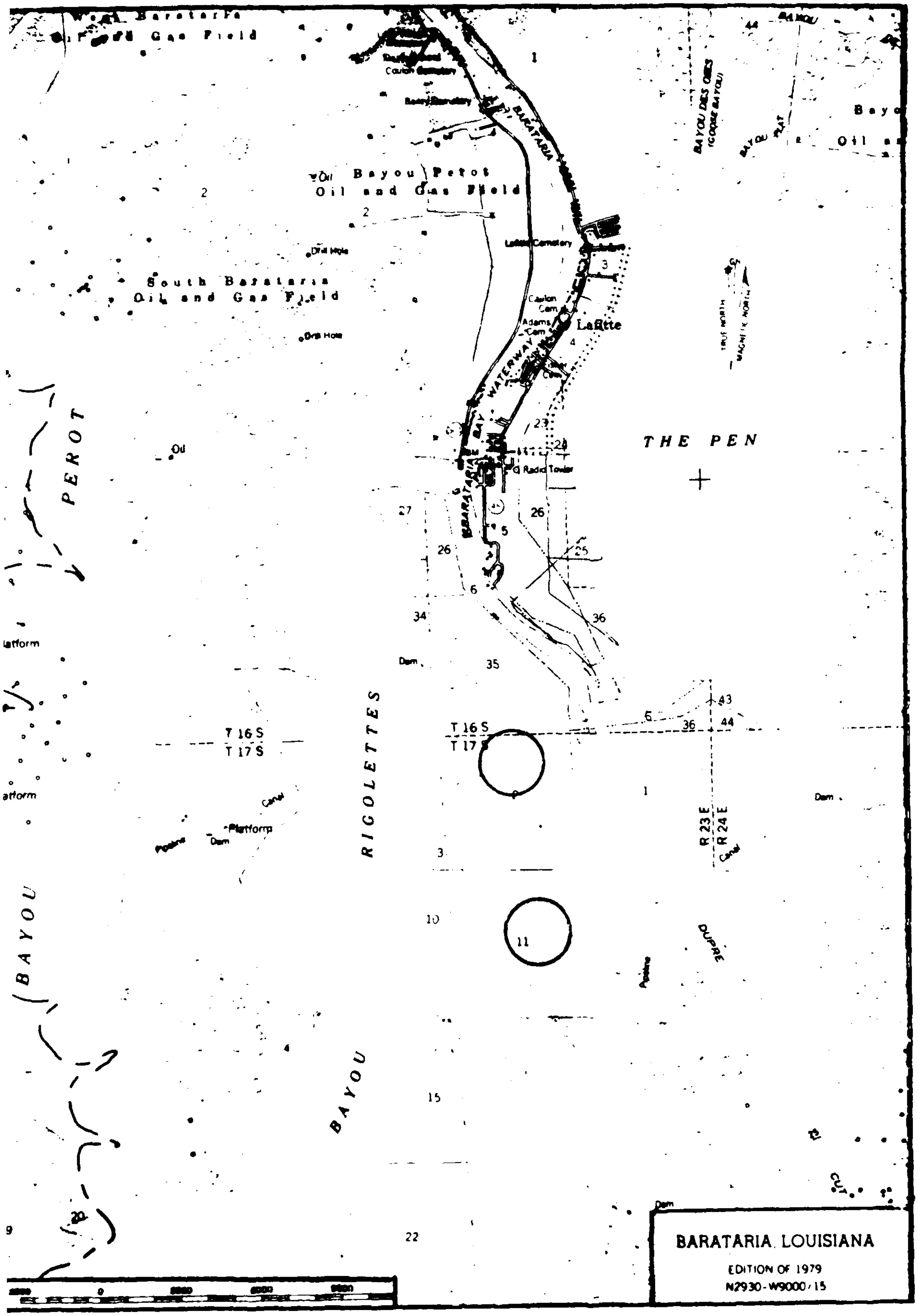


Figure 2. Location of the North and South Lafitte Bald Eagle nests.

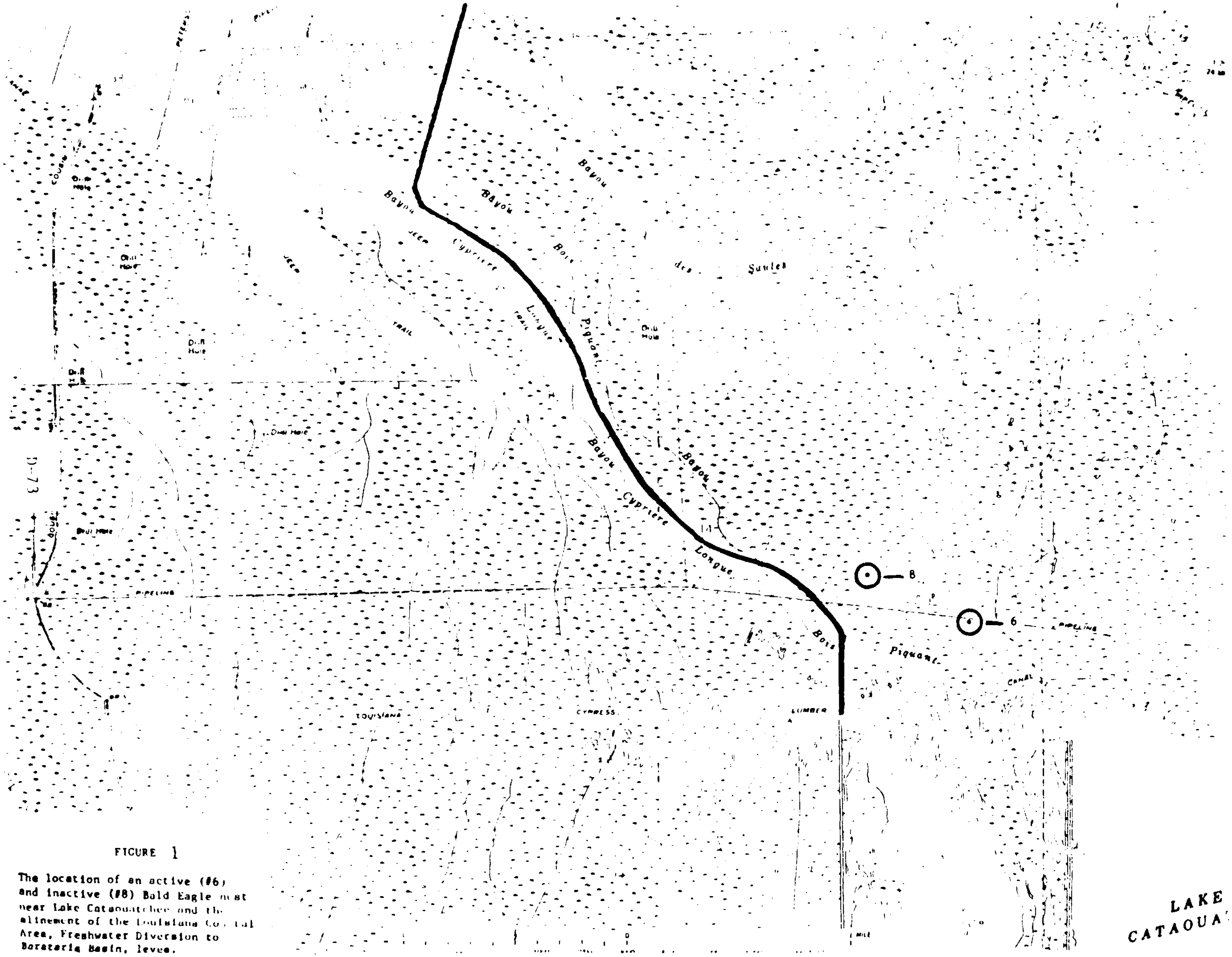


FIGURE 1

The location of an active (#6) and inactive (#8) Bald Eagle nest near Lake Cataouatche and the alinement of the Louisiana Coastal Area, Freshwater Diversion to Barataria Basin, levee.

This completes consultation under Section 7 of the Endangered Species Act. We appreciate your cooperation in this effort. If you have any questions or comments regarding this Biological Opinion, please contact Mr. Fred M. Bagley at this office.

Sincerely yours,

Dennis B. Jordan

Dennis B. Jordan
Field Supervisor
Endangered Species Field Office

cc: RD, FWS, Atlanta, GA (AFA/SE)
ES, FWS, Lafayette, LA
Department of Wildlife & Fisheries, New Orleans, LA

inspections of the habitat, a review of the pertinent literature, discussions with your personnel, a review of your biological assessment, and other correspondence as indicated under Consultation History. Our opinion is based upon the following considerations.

(1) In the future, without the project, the nesting habitat at Lake Cataouatche and at Lafitte will likely be severely impacted as a result of saltwater intrusion

(2) The project offers the opportunity to prevent saltwater intrusion and thus prevent the loss of bald eagle nesting habitat at Lake Cataouatache.

(3) NODCE has committed itself to a tissue sampling program within the receiving area (page 17-18, Biological Assessment Amendment #2).

(4) NODCE has committed itself to compensate for any future loss of bald eagle reproductive success within the project area due to the bioaccumulation of toxic materials.

Conservation Recommendations

Over the course of this consultation, the Service has made two conservation recommendations. These were for NODCE to conduct a tissue sampling program within the receiving area and for NODCE to commit itself to compensate for any loss in eagle reproductive success within the project area due to bioaccumulation of toxic materials. You have been most cooperative in accepting these recommendations. Our only additional recommendations are as follows.

1. All construction work conducted within one mile of the Lake Cataouatche eagle nest be carried out during the non-nesting period, May 15 - October 1 of any year.

2. The tissue sampling effort be conducted 3 years prior to the initiation of freshwater diversion and for 4 years after initiation of diversion. After completion of the 4 year data gathering period, sampling should continue on a periodic basis. As a minimun, we recommend that such sampling be conducted every 3 years until the end of the project life, or until the bald eagle no longer utilizes the project area. We recognize that the final determination of the frequency of this sampling should be based on our agency's mutual review of the 7 years sampling data.

Incidental Take

The 1982 amendments to the Endangered Species Act requires addressing of incidental taking from proposed actions for which formal consultation is being conducted. In our view there will be no incidental take associated with this project.

Cumulative Effects

The introduction of pollutants to the bald eagle food chain in the project area is both a direct result of the project and a cumulative effect of State and private actions. The subject project will introduce the water bearing the pollutants to the eagle's habitat. Various State and private actions will at least partially determine which pollutants are present in that water.

The Biological Assessment Amendment #2 states correctly that much of the bald eagle's decline has been attributed to the accumulation of toxic materials, especially pesticides, through the food chain. Most of these materials have not killed the birds outright, but have resulted in eggshell thinning. The release of Mississippi River water would introduce pollutants into the receiving area marsh around Lake Cataouatche, and these pollutants would be incorporated into the food chain and bioaccumulated. As stated in Amendment #2 and in Tables 5 and 6 of that report, it appears the pollutants would not result in immediate and irreversible harm. Unfortunately, the long-term effects of exposure of eagles to the broad spectrum of low level toxic materials found in Mississippi River water is unknown.

According to Amendment #2, the increased concentrations of pollutants in the marshes around the Lafitte nests would be minimal. These nests are not in the main diversion route and flows through Bayou Rigolettes and Bayou Barataria would tend to restrict the flow of diverted water in this area. Also, as the water flows over the marshes, it would gradually be cleansed of pollutants.

In Biological Assessment Amendment #2 (page 17-18), we note that you have committed yourself to a tissue sampling program. We feel this program is essential to the conservation of the eagles within the project area. As you have stated, sampling will be conducted in the spring and fall at 4 stations within the receiving area, with five individuals each of catfish and nutria being collected at each station. Avian species would also be collected. One acceptable scheme for avian species collection would be to collect a sample of five mottled ducks each fall, and five gallinules each spring from the receiving area. Chemical analysis will be conducted on these samples for EPA priority pollutants within the heavy metal, pesticide, and PCB groups and other materials as described in the Biological Assessment Amendment #2, page 18.

Biological Opinion

It is the FWS' Biological Opinion that this project is not likely to jeopardize the continued existence of the bald eagle or result in the destruction or adverse modification of critical habitat. (Critical habitat has not been designated in the Federal Register for bald eagles in the southeastern United States.) This opinion is the result of field

(1) temporary closure of the diversion structure to allow identified pollutants to pass before re-initiation of diversion;

(2) supplemental feeding to provide the pair a clean food source;

(3) capture of the adult pair, and captive propagation of their young at a facility such as the Patuxent Wildlife Research Center and fostering (or hacking) of the young back into appropriate habitat in southern Louisiana; and

(4) fostering or hacking of young bald eagles in southern Louisiana from sources other than the pair(s) which nested in the project area.

August 28, 1984 - NODCE responded to FWS's letter of July 24, 1984, with a commitment to employ item 1, 3, or 4 of the July 24 letter if future monitoring indicates that unacceptable levels of contaminants resulting from project operation are adversely affecting the eagles' nesting success. The letter went on to say that as it may be many years in the future before any such problem develops (if ever), it is possible that some other action may be deemed more appropriate by our agencies at that time. Therefore, determination of which action would be most appropriate would be determined by reinitiation of consultation at the time the problem arises.

Biological Information

Three bald eagle nest territories are involved in this consultation. One territory is located within the 7,425 acre overflow area in the vicinity of Lake Cataouache, St Charles Parish (see Figure 1). Although two nests are present, only one of these has been used by eagles in recent years. Two bald eagle territories are located in the vicinity of Lafitte, Jefferson Parish (Figure 2). These nests are located approximately twenty-five miles southeast of the Davis Pond site. The Biological Assessment Amendments 1 and 2 have presented nest success data on these territories. The Lake Cataouatche nest has fledged one or two young each year since 1974. The Lafitte nests have had a combined nest success of one or two young fledged each year since 1974. The total nest success for Louisiana's bald eagles was 18 fledged young in the 1983-84 season.

Under current conditions all three nest territories are faced with eventual destruction of the nest trees due to increasing salinity resulting from saltwater intrusion (based on Biological Assessment Amendment #2, page 11 and discussions between Mr. Scott Clark, NODCE and Mr. Fred Bagley, FWS, July 11, 1984). The proposed project offers the opportunity to prevent such habitat destruction in the vicinity of the Lake Cataouatche nest by introduction of freshwater from the Mississippi River. Although saltwater intrusion into the Lafitte nesting area would be reduced by the proposed project, this probably would not be sufficient, nor of long enough duration to aid the re-establishment of a fresher type vegetation and prevent loss of the nest trees.

Consultation History

Listed below are dates and subjects of correspondence leading up to and included in this formal consultation.

September 23, 1980 - New Orleans District, Corps of Engineers (NODCE) requested information on listed and proposed threatened and endangered species that may be affected by the proposed project with the diversion structure located in the Lac des Allemands vicinity.

October 15, 1980 - FWS responded that the bald eagle, brown pelican, and Arctic peregrine falcon may occur in the project area.

July 14, 1981 - NODCE provided FWS a biological assessment and concluded that the project as proposed would have no adverse impact on the subject species.

July 28, 1981 - FWS concurred with the July 14, 1981 biological assessment.

January 28, 1983 - NODCE amended the original biological assessment by addressing the potential impacts on threatened and endangered species of relocating the Barataria Basin freshwater diversion site from Lac des Allemands to Lake Cataouatche.

March 2, 1983 - FWS review of the supplemental assessment revealed that it failed to consider the impact of increased water levels (resulting from the project) upon bald eagle nesting habitat. FWS requested NODCE revise the supplemental assessment to address this matter.

March 28, 1983 - After additional review of the January 28, 1983, assessment, FWS informed NODCE that in the Service's opinion this project may affect the endangered bald eagle, and that additional information regarding salinity, water levels, and contaminant analysis should be developed prior to initiation of formal consultation.

October 17, 1983 - NODCE informed FWS that 'several institutional problems' with St. Charles Parish had caused delays, may result in some modifications in project design, and the requested additional information would be delayed until the situation is resolved.

July 5, 1984 - NODCE provided FWS with Biological Assessment (#2) and indicated that formal consultation had been initiated.

July 24, 1984 - FWS suggested to NODCE that a commitment be incorporated into the project plans to compensate for any future loss of bald eagle reproductive success within the project area due to the bioaccumulation of toxic materials. Actions suggested to be included under the commitment were as follows:

United States Department of the Interior

FISH AND WILDLIFE SERVICE
JACKSON MALL OFFICE CENTER
300 WOODROW WILSON AVENUE, SUITE 3185
JACKSON, MISSISSIPPI 39213

September 12, 1984

Colonel Eugene S. Witherspoon
New Orleans District, Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160

Dear Colonel Witherspoon:

This letter presents the Biological Opinion of the Fish and Wildlife Service (FWS) regarding the effects of the Louisiana Coastal Area Study (LCA), Freshwater Diversion to Barataria Basin Project on the bald eagle (*Haliaeetus leucocephalus*). It responds to your letter of July 5, 1984, which provided additional information and indicated that formal consultation has been initiated. This letter addresses the consultation requirements of Section 7(a)(1) and (2) of the Endangered Species Act of 1973, as amended, and does not address requirements of other environmental statutes. The log number assigned to this consultation is 4-3-81-007.

Project Description

The Barataria Basin aspect of the LCA study would introduce freshwater from the Mississippi River into the Barataria Basin at Davis Pond, St. Charles Parish, in order to maintain the 15 parts per thousand (ppt) isohaline at the "Ford Line". The Barataria Basin diversion facilities at Davis Pond would consist of a box culvert control structure in the Mississippi River levee, an inlet channel 520 feet long with a bottom width of 200 feet, an outlet channel 11,250 feet long with a bottom width of 200 feet, levees along the channel and 13.3 miles of guide levees along the overflow area, a 175-acre dredged material disposal area, a 7,425-acre overflow area, 5 weirs, a new drainage canal 4,000 feet long along Willowdale Boulevard, a pumping station located at the intersection of the new drainage canal and the access canal south of U.S. Highway 90, and an additional pump at the St. Charles Parish pumping station on Cousin Canal, and clearing and snagging of 7.9 miles of drainage canals. To achieve the desired isohaline at "Ford Line", Mississippi River water would be diverted from January through May on a flexible schedule. Based on a typical 10-year rainfall cycle, a maximum of 10,650 cfs would be diverted once every 10 years, from 3,000 to 9,400 cfs in six years, and little or no diversions would be required in the remaining three years. During diversion, water would flow through the overflow area at a depth of 1 to 2 feet. Duration of ponding would vary depending on the diversion necessary. Flow over the diversion area would be controlled by a system of five weirs located along the northern shore of Lake Cataouatche. This action will have a project life of fifty years.

Reach B (Hwy 90 to flair):	54 acres WS
	14 acres BLH
	20 acres FM
East Channel Levee:	9 acres BLH
West Guide Levee:	30 acres WS
	10 acres BLH
West Guide Levee Extension:	28 acres WS
	42 acres BLH
Bayou Verret and Borrow Canal:	73 acres FM
	37 acres water
Ditch Clean-out:	2.5 acres water
Marsh Creation Site:	175 acres water

Oakville (Mile 70.4) - 5,325 cfs

Inlet Channel:	2 acres developed
Structure:	1.8 acres developed
Structure to Bridge:	5 acres developed
	2 acres BLH
Bridge:	0.6 acres developed
Outlet Channel I:	11 acres BLH
	55 acres WS
	83 acres FM
	28 acres water
	15 acres developed
Transition:	1 acre water
Outlet Channel II:	2 acres FM
	62 acres water
	7 acres developed

Oakville (Mile 70.4) - 3,550 cfs

Inlet Channel:	1.7 acres developed
Structure:	1.1 acres developed
Structure to Bridge:	3.5 acres developed
	1.0 acre BLH
	0.2 acres developed
Bridge:	0.3 acres developed
Outlet Channel I:	8 acres BLH
	39 acres WS
	58 acres FM
	20 acres water

	11 acres other
Transition:	0.9 acres water
Outlet Channel II:	64 acres water
	7 acres developed

Myrtle Grove (Mile 58.7) - 5,325 cfs

Inflow to Structure:	0.4 acres BLH
	3.0 acres developed
Structure and Bridge:	2.4 acres BHL
Outlet Channel I:	17.2 acres BLH
Outlet Channel II:	20 acres acres developed
	24 acres P
Outlet Channel III:	23.6 acres Wilkinson Canal
	6.5 acres disposal area
	13.2 acres brackish marsh (BM)
Outlet Channel IV:	51.4 acres Wilkinson Canal
	34.0 acres disposal area
	51.1 acres BM
Outlet Channel V:	49.1 acres Wilkinson Canal
	63.5 acres BM
Outlet Channel VI:	35.4 acres open water
	35.4 acres BM
Outlet Channel VII:	56.8 acres Bayou McCutchen
	47.6 acres BM

Myrtle Grove (Mile 58.7) - 3,550 cfs

Inflow to Structure:	0.4 acres BLH
	2.4 acres developed
Structure and Bridge:	1.3 acres BLH
Outlet Channel I:	14.4 acres BLH
Outlet Channel II:	2.0 acres developed
	19.5 acres P
Outlet Channel III:	23.6 acres Wilkinson Canal
	6.5 acres disposal area
	8.9 acres BM
Outlet Channel IV:	51.4 acres Wilkinson Canal
	34.0 acres disposal area
	51.1 acres BM
Outlet Channel V:	49.1 acres Wilkinson Canal
	63.4 acres BM
Outlet Channel VI:	35.4 acres open water
	35.4 acres BM
Outlet Channel VII:	56.8 acres Bayou McCutchen
	47.6 acres BM

Big Mar (Mile 81.5) - 6,600 cfs

Inlet Channel:	4 acres BLH
	4 acres developed
Structure:	2.8 acres developed
Outlet Channel:	18 acres BLH
	6 acres WS
Outlet Channel II:	5 acres intermediate marsh (IM)
	9 acres water
Outlet Channel III:	0.5 acres IM
	2 acres spoil bank
	44.5 acres water
Caernarvon Guide Dike:	10 acres IM
	2 acres spoil bank
	17 acres water

Section 4. METHODOLOGIES FOR ESTIMATING HABITAT CHANGES IN THE STUDY AREA

D.4.1. This section contains information concerning the methodologies used for estimating the without and with project habitat acreages for the Barataria and Breton Sound Basins. Examples of the calculations for each habitat type are included as well as tables demonstrating the with and without project habitat acreages over the project life.

METHODOLOGY FOR ESTIMATING FUTURE WITHOUT PROJECT HABITAT ACREAGES IN THE BARATARIA BASIN

D.4.2. Information from the Mississippi Deltaic Plain Region (MDPR) Ecological Characterization: A Habitat Mapping Study (Wicker, 1980)[1/] was used to project future without project habitat acreages for the Barataria Basin portion of the study area. The MDPR project identified and measured habitats in the area and illustrates change over a given period of time. Two sets of 1:24,000 habitat maps were prepared, one for 1955-56 and one for 1978. The habitat areas for each time period were measured using an electronic digitizer. By calculating the change from the mid-1950's to 1978, it was possible to determine the habitat trends which occurred during the 22-year period and apply them to the period 1978-2035 by reducing the remaining acreage in each year by the annual loss rate determined for the period 1956-1978.

D.4.3. Approximately 17 percent of the Barataria Basin portion of the study area was not covered by the MDPR mapping project. In order to determine the acreages of the various habitat types in this excluded area, the habitats were outlined on appropriate 1:24,000 United States Geological Survey (USGS) quadrangle maps and then electronically planimetered at the New Orleans District. The USGS quadrangle maps were

1/ Wicker, K.M. 1980. Mississippi Deltaic Plain Region ecological characterization : a habitat mapping study. A user's guide to the habitat maps. US Fish and Wildlife Service, Office of Biological Services FWS/OBS-79/07.

visually compared with October 1978 color infrared photographs when outlining the habitats in order to ensure representation of 1978 conditions. These acreages were then added to those covered by the MDPR study and the trends determined in the MDPR study were applied to the total acreage.

D.4.4. Explanations concerning the determination of future without project acreages for the various habitat types are presented below. Table D-4-1 shows the resultant acreages in tabular form.

BOTTOMLAND HARDWOODS (BLH) AND WOODED SWAMP (WS)

D.4.5. Based on the MDPR study, the Barataria Basin contained 65,000 acres of BLH and WS in 1956 and 48,000 acres in 1978.

$$65{,}000 - 48{,}000 = 17{,}000;\ 17{,}000 \div 22 \text{ years} = 773;$$
$$773 \div 65{,}000 = 1.19\% \text{ per year}$$

Therefore, a 1.19 percent annual reduction rate was applied to the total acreages of BLH and WS in the Barataria Basin area. The total acreages of these habitat types in 1978 were 43,470 and 169,774, respectively. These acreages include the area not covered by the MDPR study.

TOTAL MARSH (TM)

D.4.6. In the portion of the Barataria Basin covered by the MDPR study, there were 532,700 acres of TM in 1956 and 401,439 acres in 1978.

$$532{,}700 - 401{,}439 = 131{,}261;\ 131{,}261 \div 22 \text{ years} = 5{,}967;$$
$$5{,}967 \div 532{,}700 = 1.12\% \text{ per year}$$

Therefore, a 1.12 percent annual reduction rate was applied to the total acreage of TM in the Barataria Basin area. The acreage of TM in 1978 was 465,797. This includes 64,358 acres of fresh marsh not covered by the MDPR study.

TABLE D-4-1

COMPARISON OF HABITAT TYPES WITH AND WITHOUT PROJECT - BARATARIA BASIN

Habitat Type	1978 With[1]	1978 W/O[2]	1985 With	1985 W/O	1995 With	1995 W/O	2005 With	2005 W/O	2015 With	2015 W/O	2025 With	2025 W/O	2035 With	2035 W/O
	Target Years													
Bottomland Hardwoods[3]	43,470	43,470	39,947	39,947	35,404	35,404	31,378	31,378	27,810	27,810	24,647	24,647	21,844	21,844
Wooded Swamp[3]	169,774	169,774	155,989	155,989	138,249	138,249	122,249	122,249	108,593	108,593	96,243	96,243	85,298	85,298
Fresh/Intermediate Marsh	196,647	196,647	164,002	164,002	138,454	124,538	121,464	97,632	111,078	75,330	105,786	58,122	104,424	44,845
Brackish Marsh	111,661	111,661	114,422	114,422	166,065	113,465	113,671	108,471	108,691	100,981	102,188	91,788	94,924	81,926
Saline Marsh	157,489	157,489	152,059	52,059	146,648	144,625	141,600	137,554	136,898	130,829	132,525	124,433	128,462	118,349
Total Marsh	465,797	465,797	430,483	430,483	401,167	384,628	376,735	343,657	356,667	307,050	340,499	274,343	327,810	245,120

1/ With Project

2/ Without Project

3/ The project claims no quantified benefit to bottomland hardwoods and wooded swamp. Therefore, with and without project acreages were assumed the same.

FRESH/INTERMEDIATE MARSH (F/I)

D.4.7. In the MDPR study, the acreages of fresh and intermediate marsh were determined for 1978; however, for 1956, the marsh types in the study were classified simply as fresh versus nonfresh. Intermediate marsh was included in the nonfresh category. It was, therefore, necessary to determine what portion of the nonfresh marsh was intermediate in 1956. It is known that the intermediate marsh portion of the nonfresh category lies within the area classified as brackish and it is possible to determine the intermediate/brackish versus saline marsh in 1956 because a dotted line depicting the brackish-saline marsh interface is drawn on the 1956 MDPR habitat maps. The acreages of intermediate/brackish versus saline were determined by planimetering. Once the acreage of the intermediate/brackish versus saline was determined, it was necessary to determine the percentage of intermediate versus brackish. In order to obtain this information, the assumption was made that the proportion of intermediate to brackish in 1956 was the same as in 1978 as shown below.

	1978 acres	1956 acres
Intermediate	84,382	$\frac{\text{Intermediate}}{\text{Total}}$ = 43%; 43% x 92,065 = 39,588 I
Brackish	111,661	$\frac{\text{Brackish}}{\text{Total}}$ = 57%; 57% x 92,065 = 52,477 B
Total	196,043	

Once the intermediate marsh acreage was determined, it was added to the fresh marsh acreage to yield the F/I marsh category. Fresh and intermediate acreages were combined because the wildlife values of the two marsh types are similar.

D.4.8. The total acreage of F/I marsh in the Barataria Basin in 1956 was 303,097. By 1978, the acreage had been reduced to 132,289.

$$303{,}097 - 132{,}289 = 170{,}808;\ 170{,}808 \div 22 \text{ years} = 7{,}764;$$
$$7{,}764 \div 303{,}097 = 2.56\% \text{ per year.}$$

Therefore, a 2.56 percent reduction rate was applied to the total acreage of F/I marsh in the Barataria Basin area.

SALINE MARSH (SM)

D.4.9. As discussed previously, the nonfresh marsh types were separated on the 1956 habitat maps and their acreages determined by planimetering. The 1956 SM acreage was determined in this manner. The 1978 SM acreage was electronically digitized in the MDPR study and was readily available.

D.4.10. In 1956, there were 177,126 acres of SM in the Barataria Basin and 157,489 acres remained in 1978.

$$177{,}126 - 157{,}489 = 19{,}637;\ 19{,}637 \div 22 \text{ years} = 893;$$
$$893 \div 157{,}126 = 0.50\% \text{ per year.}$$

Therefore, a 0.50 percent annual reduction rate was applied to the total acreage of SM in the Barataria Basin area. The total acreage of SM in 1978 was 157,489 acres.

BRACKISH MARSH (BM)

D.4.11. The methodology for determining the acreage of BM has been discussed previously. It can be assumed that the difference between total marsh and the combined fresh/intermediate and saline marsh for a given year equals brackish marsh for that year. Therefore, the brackish marsh acreage for any given year was determined as follows:

Total Marsh in Year - Combined F/I and Saline Marsh in Year = Brackish Marsh in Year.

The projected acreages of each habitat type in the Barataria Basin area were determined by applying the annual percentage changes to each future year during the period 1978-2035. The base year (1978) and each target year (10-year increments) acreages were extrapolated and tabulated (see table D-4-1).

METHODOLOGY FOR ESTIMATING FUTURE WITH PROJECT HABITAT ACREAGES IN THE BARATARIA BASIN

D.4.12. Determining habitat acreage changes in the Barataria Basin under with project conditions involved estimating the magnitude of habitat type shifts and land losses under various salinity regimes. A comparison of existing and projected with project 5 and 15 ppt isohalines indicates that any shift would be insignificant. First, the habitat area affected is small because of the close proximity of the isohalines compared. Second, the brackish marsh vegetation can tolerate the reduced salinities and the fresh/intermediate vegetation must outcompete the brackish vegetation to completely replace it. A more significant shift in habitat would occur between the with and without project conditions. No reasonable methodology could be developed to determine the fresh/intermediate/brackish marsh shifts during the project life. In the large zones of each type of marsh, changes would be subtle and could vary widely from location to location. Since it is not anticipated that project feasibility will depend on the shift, the most prudent course of action is to make a conservative assumption that no significant shifts would occur in the habitat types.

D.4.13. The project would significantly reduce the rate of marsh loss in the area over project life. It was assumed that the reductions in rates of loss for the various marsh types would be 50, 40, and 30 percent for fresh/intermediate, brackish, and saline marsh, respectively. The rationale and methodology used to derive the 50, 40, and 30 percent reduction rates is presented in the methodology for estimating marsh acreage changes for future with project conditions on page D-87. The project claims no benefit to bottomland hardwoods and wooded swamp; therefore, the with and without project acreages were assumed the same.

D.4.14. The methodology used in applying the reduction rates to the without project marsh acreages is described below and the results are presented in table D-4-1.

FRESH/INTERMEDIATE MARSH (FI)

D.4.15. By 1985, year 1 of project life, the acreage of F/I marsh without project is anticipated to be 164,002 acres. By 2035, it is anticipated to be 44,845 acres. It is assumed that loss of F/I marsh would be reduced by 50 percent over project life.

164,002 - 44,845 = 119,957; 119,957 x .50 = 59,579;
59,579 + 44,845 = 104,424 acres in 2035 with project

BRACKISH MARSH (BM)

D.4.16. By 1985, the acreage of BM without project is anticipated to be 114,422 acres. By 2035, it is anticipated to be 81,926 acres. It is assumed that the loss of BM would be reduced by 40 percent over project life.

114,422 - 81,926 = 32,496; 32,496 x .40 = 12,998;
12,998 + 81,926 = 94,424 acres in 2035 with project.

SALINE MARSH (SM)

D.4.17. By 1985, the acreage of SM without project is anticipated to be 152,059 acres. By 2035, it is anticipated to be 118,349 acres. It is assumed that the loss of SM would be reduced by 30 percent over project life.

152,059 - 118,349 = 33,710; 33,710 x .30 = 10,113;
10,113 + 118,349 = 128,642 acres in 2035 with project

TOTAL MARSH (TM)

D.4.18. The difference in TM in 2035 with and without project represents the total reduction of acreage losses over project life.

	Year 2035	
	With	Without
F/I	104,424	44,845
BM	92,924	81,926
SM	128,462	118,349
TM	327,810	245120

327,810	with
-245,120	without
82,690	acres

$$\frac{82{,}690}{640} = 129 \text{ square miles}$$

Therefore, it is projected that 82,690 acres or 129 square miles of TM would be saved in the Barataria Basin with project.

METHODOLOGY FOR ESTIMATING FUTURE WITHOUT PROJECT HABITAT ACREAGES IN THE BRETON SOUND BASIN

D.4.19. Information from the Mississippi Deltaic Plain Region (MDPR) Ecological Characterization: A Habitat Mapping Study (Wicker, 1980) was utilized to project future without project habitat acres for the Breton Sound Basin portion of the study. The MPDR project identified and measured habitats in the study area and illustrates change over a given period of time. Two sets of 1:24,000 habitat maps were prepared, one for 1955-56 and one for 1978. The habitat areas for each time period were measured using an electronic digitizer. By calculating the change from the mid-1950's to 1978, it was possible to determine the habitat trends which occurred during the 22-year period and apply them to the period 1978-2035 by reducing the remaining acreage in each year by the annual loss rate determined for the period 1956-1978.

D.4.20. Explanations concerning the determination of future without project acreages for the various habitat types are presented below. Table D-4-2 shows the resultant acreages in tabular form.

BOTTOMLAND HARDWOODS (BLH) AND WOODED SWAMP (WS)

D.4.21. Based on the MDPR study, Plaquemines and St. Bernard Parishes contained 51,500 acres of BLH and WS in 1956 and 34,000 acres in 1978.

$$51{,}500 - 34{,}000 = 17{,}500;\ 17{,}500 \div 22 \text{ years} = 795;$$
$$795 \div 51{,}500 = 1.54\% \text{ per year.}$$

TABLE D-4-2

COMPARISON OF HABITAT TYPES WITH AND WITHOUT PROJECT - BRETON SOUND BASIN

	Target Years													
	1978		1985		1995		2005		2015		2025		2035	
Habitat Type	With[1]	W/O[2]	With	W/O	With	W/O	With	W/O	With	W/O	With	W/O	With	W/O
Bottomland Hardwoods[3]	9,479	9,479	8,527	8,527	7,331	7,331	6,303	6,303	5,419	5,419	4,659	4,659	4,005	4,005
Wooded Swamp[3]	1,006	1,006	[illegible]	905	778	778	669	669	575	575	494	494	425	425
Fresh/Intermediate Marsh	13,595	13,595	11,072	11,072	76,889	8,258	73,425	6,159	70,115	4,593	66,955	3,426	63,938	2,555
Brackish Marsh	131,257	131,257	130,538	130,538	105,042	128,318	99,306	125,052	93,883	121,051	88,756	116,546	83,909	111,724
Saline Marsh	46,766	46,766	41,329	41,329	0	34,641	0	29,035	0	24,335	0	20,397	0	17,096
Total Marsh	191,618	191,618	182,939	182,939	181,931	171,217	172,731	160,246	163,998	149,979	155,711	140,369	147,847	131,375

1/ With project

2/ Without project

3/ The project claims no quantified benefit to bottomland hardwoods and wooded swamp. Therefore, with and without project acreages were assumed the same.

Therefore, a 1.54 percent annual reduction rate was applied to the total acreages of BLH and WS in the Breton Sound Basin area. The total acreages of these habitat types in the Breton Sound portion of the study area in 1978 were 9,479 and 1,006, respectively.

TOTAL MARSH (TM)

D.4.22. Based on the MDPR study, in the Breton Sound Basin area, there were 224,183 acres of TM in 1956 and 191,619 acres in 1978.

$$224{,}183 - 191{,}618 = 32{,}565 \quad 32{,}565 \div 22 \text{ years} = 1{,}480;$$
$$1{,}480 \div 224{,}183 = 0.66\% \text{ per year.}$$

Therefore, a 0.66 percent annual reduction rate was applied to the total acreage of TM in the Breton Sound Basin area.

FRESH/INTERMEDIATE MARSH (F/I)

D.4.23. In the MDPR study the acreages of fresh and intermediate marsh were determined for 1978; however, for 1956, the marsh types in the study were classified simply as fresh versus nonfresh. Intermediate marsh was included in the nonfresh category. It was, therefore, necessary to determine what portion of the nonfresh marsh was intermediate in 1956. It is known that the intermediate marsh portion of the nonfresh category lies within the area classified as brackish and it is possible to determine the intermediate/brackish versus saline marsh in 1956 because a dotted line depicting the brackish-saline marsh interface is drawn on the 1956 MDPR habitat maps. The acreages of intermediate/ brackish versus saline were determined by planimetering. Once the acreage of the intermediate/brackish area was determined, it was necessary to determine the percentage of intermediate versus brackish. In order to obtain this information, the assumption was made that the proportion of intermediate to brackish in 1956 was the same as in 1978 as shown below. The proportion of intermediate to brackish marsh in the Plaquemines Parish portion of the Breton Sound Basin was used.

	1978 acres	1956 acres
rmediate	5,204	$\frac{\text{Intermediate}}{\text{Total}}$ = 5.4%; 5.4% x 81,500 = 4,401 I
kish	90,546	$\frac{\text{Brackish}}{\text{Total}}$ = 94.6%; 94.6% x 81,500 = 77,099 B
l	95,750	

24. Once the intermediate marsh acreage was determined, it was d to the fresh marsh acreage to yield the F/I marsh category. Fresh intermediate acreages were combined because the wildlife values of two marsh types are similar.

25. The total acreage of F/I marsh in the Breton Sound Basin area 956 was 37,325. By 1978, the acreage had been reduced to 13,595.

$$37{,}325 - 13{,}595 = 23{,}730;\ 23{,}730 \div 22 \text{ years} = 1{,}079;$$
$$1{,}079 \div 37{,}325 = 2.89\% \text{ per year}$$

efore, a 2.89 percent reduction rate was applied to the total age of F/I marsh in the Breton Sound Basin portion of the study .

NE MARSH (SM)

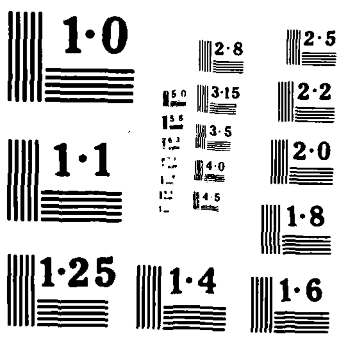
26. As discussed previously, the nonfresh marsh types can be rated on the 1956 habitat maps and their acreages determined by imetering. The 1956 SM acreage was determined in this manner. The SM acreage was electronically digitized in the MDPR study and was lly available.

956, there were 76,028 acres of SM in the Breton Sound Basin portion e LCA study area and 46,766 acres remained in 1978.

$$76{,}028 - 46{,}766 = 29{,}262;\ 29{,}262 \div 22 \text{ years} = 1{,}330;$$
$$1{,}330 \div 76{,}028 = 1.75\% \text{ per year.}$$

AD-A152 704   LOUISIANA COASTAL AREA LOUISIANA FRESHWATER DIVERSION   6/7
TO BARATARIA AND BR..(U) ARMY ENGINEER DISTRICT NEW
ORLEANS LA D L CHEW SEP 84

UNCLASSIFIED   F/G 13/2   NL


1·0
2·8
2·5
3·15
2·2
3·5
1·1
2·0
4·0
4·5
1·8
1·25
1·4
1·6

Therefore, a 1.75 percent annual reduction rate was applied to the total acreage of SM in the Breton Sound Basin area. The total acreage of SM in the 1978 was 46,766 acres.

BRACKISH MARSH (BM)

D.4.27. The methodology for determining the acreage of BM has been discussed previously. It was assumed that the difference between total marsh and the combined fresh/intermediate and saline marsh for a given year equals brackish marsh for that year. Therefore, the brackish marsh acreage for any given year was determined as follows:

Total Marsh in Year - Combined F/I and Saline Marsh in Year = Brackish Marsh in Year.

D.4.28. The acreages of each habitat type in the Breton Sound Basin portion of the study area was determined by applying the annual percentage changes to each future year during the period 1978-2035. The base year (1978) and each target year (10-year increments) acreages were extrapolated and tabulated (see table D-4-2).

METHODOLOGY FOR ESTIMATING FUTURE WITH PROJECT HABITAT ACREAGES IN THE BRETON SOUND BASIN

D.4.29. In order to determine the habitat acreage changes under with project conditions over the project life for the Breton Sound Basin, several important assumptions were made. First, since the diversion in this area would introduce fresh water directly into relatively higher salinity areas, it was assumed that significant shifts in the marsh types would occur. Second, it was assumed that the diversion would significantly reduce the rate of marsh loss over the project life. It was assumed that the reductions in rates of loss for the various marsh types would be 50, 40, and 30 percent for fresh/ intermediate, brackish, and saline marsh, respectively. The rationale and methodology used to derive the 50, 40, and 30 percent reduction rates is presented in the

discussion of the methodology for estimating marsh acreage changes for future with project conditions on page D-87. The project claims no benefit to bottomland hardwoods and wooded swamp; therefore, the with and without project acreages were assumed the same.

D.4.30. The methodology used to determine and quantify the habitat shifts and with project acreages is described below and the results are presented in table D-4-2.

FRESH/INTERMEDIATE MARSH (F/I)

D.4.31. In projecting the fresh/intermediate marsh area under with project conditions, two significant changes were quantified. One change is in the increase in fresh/intermediate marsh and the decrease in brackish marsh due to salinity changes. The other change is in the reduction in the rate of marsh loss due to a more stable salinity regimen. The shift between fresh/intermediate and brackish marsh types would occur in a relatively short time after project implementation and the marsh loss would be uniform throughout the project life. Therefore, the shift in marsh types was quantified first and the resultant acreage was reduced for the rate of marsh losses.

D.4.32. The increase in fresh/intermediate marsh and the decrease in brackish marsh was based on the shift in the 5 ppt isohaline under without and with project conditions. Because the shift is estimated to occur within the first 10 years of project life, the without project and existing 5 ppt isohalines are approximately the same at initiation of the diversions. Thus, the marsh area involved in the shift is the area between the existing and with project 5 ppt isohalines. It was not reasonable to assume that the entire area less than 5 ppt would convert to F/I marsh because the brackish marsh (BM) vegetation already existing in the area can tolerate the reduced salinities and the F/I vegetation must outcompete the BM vegetation to completely replace it. Due to the lack of a comparable study to determine the percentage of brackish marsh that would convert to fresher marsh types under these conditions, it was assumed that approximately 50 percent of the area between the existing

and with project 5 ppt isohalines would become F/I marsh. This was based on meetings and conversations with individuals knowledge in the field of marsh vegetation ecology. A line depicting approximately one-half of the affected area with less than 5 ppt salinities was drawn on the map. The line represents the with project F/I to BM interface. The existing and with project 5 ppt isohalines and the line representing the new F/I to BM interface are shown on plate 10 of the Main Report. The entire affected land and water area was planimetered to determine the total acreage of this area. The total acreage of the affected area is 116,677 acres. In order to determine the acreage of F/I marsh in this area, representative 1:24,000 quadrangle maps were selected and the marsh to open water ratio was obtained from the MDPR study. Based on the land and water ratio, it was determined that 80,507 acres of the affected area will become F/I marsh.

D.4.33. The rate of marsh loss which would occur in this area over the project life was determined by annualizing the loss rates between 1956 and 1978 obtained by comparing representative quadrangle maps. The loss for this area was calculated to 0.92 percent per year. Before applying this annual reduction rate to the remaining acreage in each year over the project life, the 50 percent with project reduction in the loss rate of F/I marsh was incorporated by multiplying by the reciprocal of the 50 percent reduction in loss rate.

$$0.92\% \text{ annual loss rate} \times .50 = 0.46\%$$

Therefore, a 0.46 percent annual reduction rate was applied to the remaining acreage each year of project life.

BRACKISH MARSH (BM)

D.4.34. Once the with project F/I area and F/I to BM interface was established, it was necessary to determine the new BM area. In order to accomplish this task, the with project 15 ppt isohaline was plotted on a 1:250,000 scale map. It was assumed that all marsh inside this line

would become brackish. Once the new brackish area was established, the methodology used to determine with project acreages of BM was very similar to that described above for F/I marsh. The entire new area was planimetered to determine the total acreage of the brackish area. In order to determine the acreage BM in the area, representative 1:24,000 quadrangle maps were selected and the marsh to open water ratio was obtained from the MDPR study. The total acreage of the new brackish area is 359,284 acres. Based on the information in the MDPR study, 111,110 acres of the new area will become BM.

D.4.35. The rate of loss which would occur in this affected area over the project life was determined by annualizing the loss rates between 1956 and 1978 obtained by comparing representative quadrangle maps. The loss rate for this area was calculated to be 0.94 percent per year. The 40 percent with project reduction in the loss rate of BM was incorporated by multiplying by the reciprocal of the 40 percent reduction in loss rate.

$$0.94\% \text{ loss rate} \times .60 = 0.564\%$$

Therefore, a 0.564 percent annual reduction rate was applied to the remaining acreage each year of project life.

SALINE MARSH (SM)

D.4.36. Based on the projections described above, no SM will remain in the Breton Sound Basin with project conditions.

TOTAL MARSH (TM)

D.4.37. The difference in TM in 2035 with and without project represents the total acreage saved over the project life.

	Year 2035	
	With	Without
F/I	63,938	2,555
BM	83,909	111,724
SM	0	17,096
TM	147,847	131,375

147,847 with
-131,375 without
16,472 acres

$$\frac{16,472}{640} = 26 \text{ square miles}$$

METHODOLOGY FOR ESTIMATING MARSH ACREAGE CHANGES FOR FUTURE WITH PROJECT CONDITIONS

D.4.38. In order to determine reductions in rates of marsh loss in the study area due to project implementation, information from a study conducted adjacent to the Atchafalaya River was used. Data on marsh loss reductions associated with operation of the Bayou Lamoque structure was not available, nor would it be directly applicable in this analysis. Diversions at Lamoque are into a high salinity area where freshwater effects are neither as long-term nor as extensive as diversions at the head of an estuarine system. The Lower Atchafalaya River (LAR) is a large area in Louisiana where fresh water flows directly into a marsh. The LAR runs west of the Terrebonne Parish marshes and thus fresh, brackish, and saline marshes all receive approximately similar river influence. It is recognized that freshwater diversions in Barataria and Breton Sound Basins would be at the head of the estuary and would influence brackish and saline marshes to a lesser degree than fresh marshes. The situation in Terrebone Parish is not exactly similar to that in the study area, but it is the only area where marsh reductions due to river influence have been analyzed.

D.4.39. Over the 23 years from 1955 to 1978, all of Terrebonne Parish experienced marsh loss (Wicker, 1980). A study by Baumann and Adams (1981) indicated a gain in marsh during the 1972-78 period in certain areas. This gain was during the high-water years of 1973-75 when extensive sediments were carried to the marshes. Since the diversions proposed in this report would not contain large amounts of sediments, these short-term gains were not utilized in the loss per year calculations. Figure 4-1 illustrates the percent marsh loss per year from 1955-1978 by quadrangle. It can be seen that quadrangles influenced by the LAR experienced far less loss per year than quadrangles further east. Table D-4-3 show the number of acres in 1955, the number of acres in 1978 and the loss rate per year for selected quadrangles. The loss per year is calculated by dividing the 1955-78 loss by the 1955 acreage and then dividing the answer by 23 years.

FIGURE 4-1

MARSH LOSS RATES
TERREBONNE AND ST. MARY PARISHES
(PERCENT LOSS PER YEAR, 1956-1978, FROM WICKER)

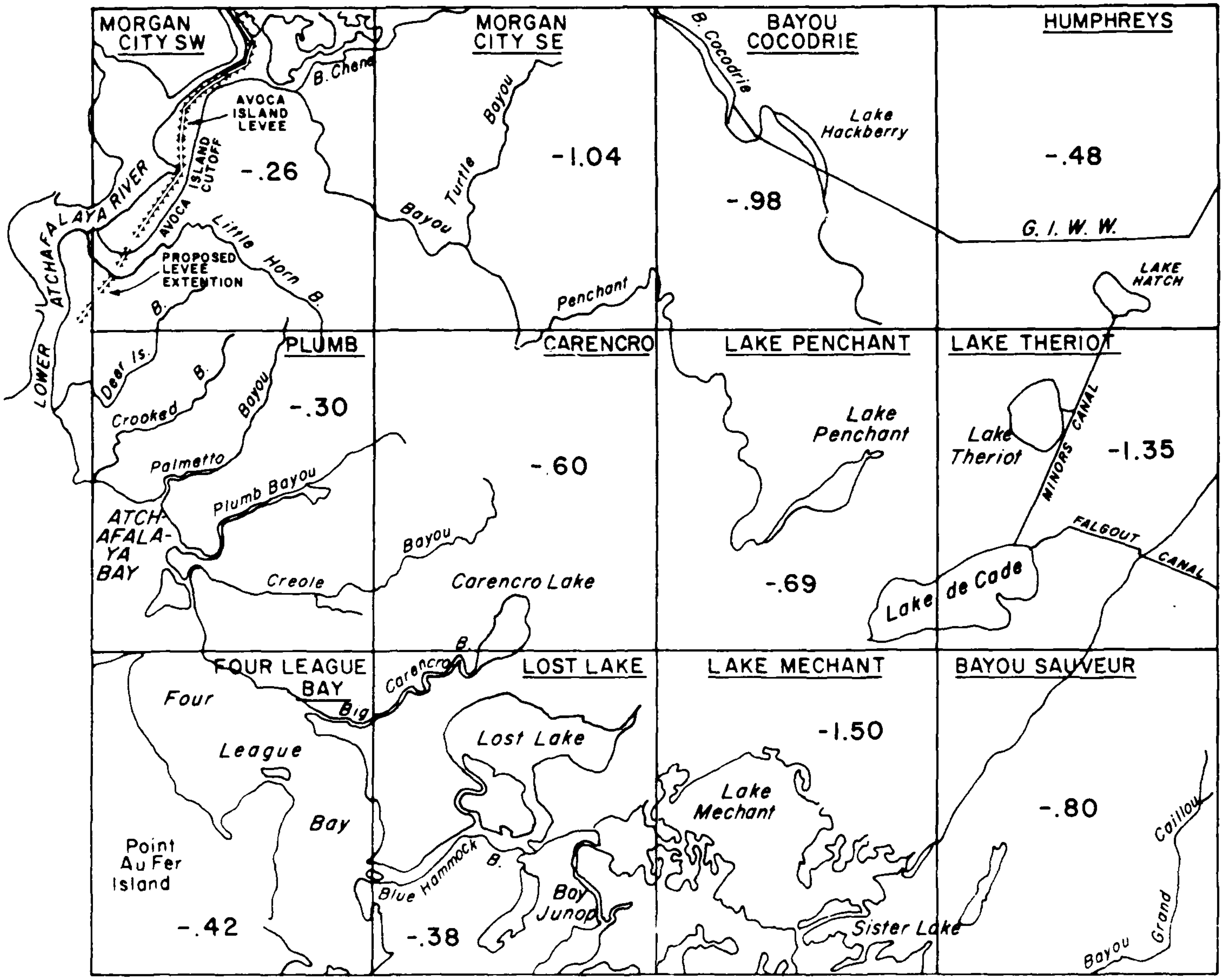


TABLE D-4-3

MARSH LOSS IN TERREBONNE PARISH

Quadrangle	# acres in 1955-56	# acres in 1978	loss rate per year
Morgan City SW	18,573	17,464	0.26%
Morgan City SE	34,468	26,192	1.04%
B. Cocodrie	22,833	17,665	0.98%
Humphreys	10,300	9,172	0.48%
Plumb	30,129	28,029	0.30%
Carencro	39,719	34,229	0.60%
L. Penchant	36,968	31,128	0.69%
L. Theriot	30,774	21,192	1.35%
Four League	19,195	17,349	0.42%
Lost Lake	29,115	26,575	0.38%
L. Merchant	28,468	18,619	1.50%
B. Sauveur	36,297	29,494	0.80%
E. Bay Junop	13,178	11,975	0.40%
Grand B. du Large	15,605	14,042	0.44%
Dog Lake	24,998	19,386	0.98%
Cocodrie	20,003	14,233	1.25%
L. Quitman	26,321	19,191	1.18%
Oyster Bayou	7,817	7,017	0.44%
Point au Fer	12,581	11,281	0.45%

FRESH MARSH

D.4.40. The Morgan City SW, Plumb, and Carencro quadrangles were considered typical of areas that receive river overflow in the fresh marsh zone. The marsh loss rate for the western fresh marsh was estimated by calculating the percentage of fresh marsh that each quadrangle contributed to the total zone. That percentage was then multiplied by the annual loss rate per quadrangle. Results were then added to obtain the loss rate for the entire zone. These computations are summarized below.

Western Zone

Morgan City SW,	21% of western fresh area x 0.26% loss = 0.035
Plumb	34% of western fresh area x 0.30% loss = 0.102
Carencro	45% of western fresh area x 0.60% loss = 0.270
	Loss rate in entire western zone = 0.427 or 43%

The quadrangles listed below are considered characteristic of those that do not receive any input of nutrients or sediments from the LAR. They are too far from any distributaries of the LAR.

Eastern Zone

Morgan City SE	26.0% of eastern fresh area x 1.04% loss = 0.270
B. Cocodrie	17.0% of eastern fresh area x 0.98% loss = 0.167
Humphreys	76.0% of eastern fresh area x 0.48% loss = 0.036
L. Penchant	27.3% of eastern fresh area x 0.69% loss = 0.188
L. Theriot	22.2% of eastern fresh area x 1.35% loss = 0.300
	Loss rate in entire eastern zone = 0.961 or 96%

reduction in land loss rates attributed to river flows was ermined as follows:

0.96% - 0.43% = 0.53%

0.53% ÷ 0.96% = 55%

ce the diversion in the Louisiana Coastal Study would divert only ited amounts of sediment to the fresh marshes of Barataria and Breton nd Basin, the above calculated 55 percent reduction in Terrebonne ish was reduced to 50 percent for use in projecting land loss uctions in this interim report.

CKISH MARSH

.41. The quadrangles listed below are those in the brackish zone t are influenced by the LAR (especially via Four League Bay).

tern Zone

r League Bay	26.0% of western brackish area x 0.42% loss	= 0.109
mb	8.0% of western brackish area x 0.30% loss	= 0.024
ter	6.2% of western brackish area x 0.44% loss	= 0.027
encro	4.6% of western brackish area x 0.60% loss	= 0.028
t Lake	40.2% of western brackish area x 0.38% loss	= 0.153
Bay Junop	5.4% of western brackish area x 0.40% loss	= 0.022
au Fer	17.0% of western brackish area x 0.45% loss	= 0.077
	Loss rate in entire western zone	= 0.440 or 44%

following quadrangles are those removed from river influence and do receive sediments or nutrients.

Eastern Zones

L. Mechant	27.7% of eastern brackish area x 1.50% loss =	0.415
L. Penchant	1.0% of eastern brackish area x 0.69% loss =	0.008
B. Sauveur	48.6% of eastern brackish area x 0.80% loss =	0.389
B. Cocodrie	0.07% of eastern brackish area x 1.25% loss =	0.008
L. Quitman	10.8% of eastern brackish area x 1.18% loss =	0.127
	Loss rate in entire eastern zone	0.947 or 95%

The reduction in land loss rates attributed to river inflow was determined as follows:

$0.95\% - 0.44\% = 0.51\%$

$0.51\% \div 0.95\% = 54\%$

In the Barataria and Breton Sound Basins marsh would be much further removed from the source of fresh water and thus would receive less sediments than the brackish marsh in Terrebonne Parish. Thus, it is considered appropriate to reduce the 54% Terrebonne Parish reduction by 14 percent to apply to Barataria and Breton Sound Basins. Accordingly, a 40 percent reduction was utilized in calculating land loss reductions in this interim report.

SALINE MARSH

D.4.42. The two quadrangles of saline marsh that are subject to river influence are Oyster Bayou and E. Bay Junop.

Western Zone

Oyster Bayou	32% of western saline area x 0.44% loss =	0.141
E. Bay Junop	68% of western saline area x 0.40% loss =	0,272
	Loss rate in entire western zone =	0.410 or 41%

he five quadrangles listed below are saline marsh that is not nfluenced by the LAR.

astern Zone

rand B du Large	21% of eastern saline area x 0.44% loss = 0.092
. Mechant	14% of eastern saline area x 1.50% loss = 0.205
. Sauveur	11% of eastern saline area x 0.80% loss = 0.087
og Lake	28% of eastern saline area x 0.98% loss = 0.279
ocodrie	26% of eastern saline area x 1.25% loss = 0.259
	Loss rate in entire eastern zone = 0.922 or 92%

eduction in land loss rates attributable to river inflows was etermined as follows:

0.92% - 0.41% = 0.51%

0 51% ÷ 0.92% = 55%

n the Barataria and Breton Sound Basins, the saline marsh is far veo from the proposed diversion site. This marsh would receive less diment than does saline marsh in Terrebonne Parish. Thus, the rebonne Parish reduction rate of 55 percent was reduced by an dditional 25 percent for use in this interim report, resulting in an verall 30 percent reduction in rate of loss of saline marsh.

EXECUTIVE SUMMARY

The attached document is the final report of the Fish and Wildlife Service (FWS) on the tentatively selected plan (TSP) for introduction of Mississippi River water into the Barataria and Breton Sound Basins of southeastern Louisiana. The TSP was developed as part of the Louisiana Coastal Area Study, authorized by resolutions of the Committees on Public Works of the United States Senate and House of Representatives, adopted April 19 and October 19, 1967, respectively. This report was prepared in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

The TSP provides for diversion of Mississippi River water via control structures to be located at Davis Pond (river mile 118.4) in St. Charles Parish and at Big Mar (river mile 81.6) in Plaquemines Parish. The Davis Pond structure would divert up to 10,650 cubic feet per second (cfs) of river water into a series of open marsh ponds north of Lake Cataouatche and thence through the remainder of the Barataria Basin, while the Big Mar structure would divert up to 6,600 cfs into the Breton Sound Basin. The diversion structures would consist of gated box culverts located in the Mississippi River levees, which could control the amount of freshwater introduced so that optimum salinity conditions could be maintained.

The proposed diversion structures would reduce the rapid marsh loss and saltwater intrusion being experienced throughout the study area. The reduction in marsh loss is attributed to reduced saltwater intrusion and increased input of nutrients and fine-grained sediments. On an average annual basis, there will be 12,200 more acres of marsh in the Breton Sound basin under with-project conditions compared to without-project conditions. On an average annual basis, there will be 41,300 more acres of marsh in the Barataria Basin under with-project conditions, compared to without-project conditions.

Studies conducted by the New Orleans District, Corps of Engineers' Recreation Planning Section considered freshwater and saltwater sportfishing as a single category. Those studies revealed that access to sportfishing areas will continue to be inadequate, causing sportfishing effort to remain constant throughout the analysis period (1985 to 2035). However, the potential catch of sportfishes, largely dependent on the acreage of marsh, will decline at a slower rate under with-project conditions. Assuming that the value of sportfishing depends in part on catch per man-day, the average value per man-day will be higher with the project. Consequently, under with-project conditions the average annual value of sportfishing is projected to increase by $36,000 in the Breton Sound Basin and $188,000 in the Barataria Basin.

Because of the reduction in marsh loss and the creation of more favorable salinity conditions, the proposed diversions will greatly benefit estuarine-dependent commercial fisheries. With the proposed freshwater diversion into the Breton Sound Basin, the annualized increase in the value of commercial harvests of shrimp, oysters,

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LOUISIANA COASTAL AREA STUDY

FRESHWATER DIVERSION TO BARATARIA AND BRETON SOUND BASINS

FISH AND WILDLIFE COORDINATION ACT REPORT

SUBMITTED TO

NEW ORLEANS DISTRICT

U.S. ARMY CORPS OF ENGINEERS

NEW ORLEANS, LOUISIANA

PREPARED BY:

DAVID M. SOILEAU, SENIOR FIELD BIOLOGIST

UNDER THE SUPERVISION OF

DAVID W. FRUGE, FIELD SUPERVISOR

U.S. FISH AND WILDLIFE SERVICE

DIVISION OF ECOLOGICAL SERVICES

LAFAYETTE, LOUISIANA

SEPTEMBER 1984

State of Louisiana

DEPARTMENT OF WILDLIFE AND FISHERIES
POST OFFICE BOX 15570
BATON ROUGE, LA 70895

J. BURTON ANGELLE, SR.
SECRETARY
(504) 925-3617

EDWIN W. EDWARDS
GOVERNOR

September 26, 1984

Mr. David Fruge'
Field Supervisor
U. S. Fish and Wildlife Service
P. O. Box 4305
Lafayette, Louisiana 70502

Re: Fish and Wildlife Coordination Act Report: Louisiana Coastal Area Study, Freshwater Diversion to Barataria and Breton Sound Basins

Dear Mr. Fruge':

Personnel of our technical staff have reviewed the above referenced report produced by your office. As you are aware, we have worked in close cooperation with your agency, the Corps of Engineers (N.O.D.), and other agencies in evaluating the effects on fish and wildlife habitats and resources that would result from the tentatively selected plan of freshwater introduction to Barataria and Breton Sound Basins.

We are in general agreement with your findings, and specifically with the joint FWS-Corps analysis, to which your report refers, of the long-term effects of supplemental freshwater, sediment and nutrient introductions in reducing salinity levels and marsh loss in the project area.

To a considerable extent, our involvement has been concerned with basic research and documentation of salinity conditions that are most conducive to high oyster yields, and in developing estimates of project-related increases in oyster production that would result from the restoration of optimal salinity regimes over historically productive oyster bottoms.

We concur with the recommendations for authorization and funding of the tentatively selected plan and cooperative studies, involving this Department and other federal and state agencies, for the design and development of the proposed structures, their operation and maintenance, and the necessary environmental monitoring programs.

Sincerely yours,

J. Burton Angelle

J. Burton Angelle
Secretary

JBA/CJK/fsb

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9450 Koger Boulevard
St. Petersburg, FL 33702

September 28, 1984 F/SER112/DM:gog
409/766-3699

Mr. David W. Fruge'
Field Supervisor
U.S. Fish and Wildlife Service
P. O. Box 4305
Lafayette, LA 70502

Dear Mr. Fruge':

As requested in your letter of September 20, 1984, the National Marine Fisheries Service (NMFS) has reviewed your proposed Fish and Wildlife Coordination Act Report (FWCAR) on the tentatively selected plan for introduction of Mississippi River water into the Barataria and Breton Sound Basins of southeastern Louisiana.

The NMFS fully concurs in your findings and recommendations as relates to fishery resources for which we are responsible. In addition we believe the feasibility of future enlargement of structures to maximize project benefits would be better ensured if Recommendation 4. on pages ix and 75 were revised. It should recommend setting aside sufficient adjacent land to enable future enlargement of structures without having to remove valuable buildings, etc.

To accomplish this we suggest that Recommendation 4. state in essence that: "The final feasibility report request (1) authority to secure sufficient land easements and/or titles to enable future enlargement of the proposed structures and (2) authority for enlargement of the proposed structures, if in the opinion of the District Engineer such enlargement would be justified to maximize project benefits."

The opportunity to review and comment on this comprehensive and thorough FWCAR is appreciated.

Sincerely yours,

for Richard J. Hoogland
Chief, Environmental Assessment
Branch

United States Department of the Interior
FISH AND WILDLIFE SERVICE
75 SPRING STREET, S.W.
ATLANTA, GEORGIA 30303

SEP 27 1984

Colonel Eugene Witherspoon
District Engineer
U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160

Dear Colonel Witherspoon:

Enclosed is the final Fish and Wildlife Coordination Act Report on the tentatively selected plan described in the draft feasibility report, "Louisiana Coastal Area, Louisiana - Freshwater Diversion to Barataria and Breton Sound Basins." Our report is transmitted to you under the authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

The report has been coordinated with the Louisiana Department of Wildlife and Fisheries and the National Marine Fisheries Service. Copies of the letter of response from those agencies are enclosed.

Your cooperation in this matter is appreciated.

Sincerely yours,

W. J. Olds Jr.

Assistant Regional Director--
Habitat Resources

Enclosure

FINAL FISH AND WILDLIFE
COORDINATION ACT REPORT

acreage in Louisiana were obtained for the years 1976-1980. Total harvest was then divided by total acreage of leases obtained from the LDWF to yield pounds per acres production. Pounds per acre were then multiplied by the net return to the fishermen to yield value per acre. Detailed calculations concerning the value of these lost leases is presented in Appendix F. The with project 5 ppt isohalines for both the Barataria and Breton Sound Basins are shown on plate 10 of the Main Report.

would remain relatively stable throughout the life of the project. The increase would be due to a variety of beneficial factors, including reduction in marsh loss, which would lead to increased production of detritus; increased levels of nutrients, which would lead to greater productivity of phytoplankton and zooplankton populations; and increased acreage and stability of areas with favorable (5-15 ppt) salinity regimes, which would reduce the incidence of predation and disease and restore areas which were historically highly productive for oysters.

D.5.4. The 100 percent increase in oyster productivity is considered to be conservative. The massive freshets that occur with openings of the Bonnet Carre Spillway have been responsible for greater increases in oyster production in following years, as have the more localized diversions at Bayou Lamoque and through breaches in the Mississippi River eastbank levee above Baptiste Collette Bayou. Ronald J. Dugas (personal communication, 24 November 1981)[1/] stated it has been his experience that oyster production at least doubles with freshwater introduction. Written documentation supporting this increase in oyster production is presented in Exhibit A of this appendix.

D.5.5. Since the project would shift isohalines in the area seaward, certain inland areas presently productive for oysters would become too fresh. It was assumed that areas inland of the with project 5 ppt isohalines would be lost to oyster production. Maps maintained by the Louisiana Department of Wildlife and Fisheries (LDWF) were reviewed to determine the acreage of leases inside the 5 ppt isohalines. In order to place a value on these leases, total pounds harvested from all leased

---

[1/] Ronald J. Dugas, State Oyster Biologist, Louisiana Department of Wildlife and Fisheries. Mr. Dugas is a recognized authority on oyster biology and the oyster fishery in Louisiana.

Section 5. METHODOLOGIES USED FOR ESTIMATING COMMERCIAL FISH AND WILDLIFE BENEFITS

D.5.1. This section contains an explanation of the methodology and concepts used for estimating commercial fish and wildlife benefits. Separate discussions are presented on both the rationale used for estimating increases in oyster production and determination of acreage of existing oyster production which would be lost due to implementation of the proposed project.

D.5.2. Benefits to commercial fish and wildlife in the study area were directly correlated to the quantity and quality of wetland habitat. The relationship between wetland habitat and fish and wildlife productivity is addressed in Appendix A, Section 6.8 of the EIS, and in Exhibit A of this appendix. The acreages of each habitat type and the methodologies by which they were determined are presented in Section 4 of this appendix. Under with project conditions, there would be a reduction in rate of loss of wetland habitat. Therefore, more habitat would exist and fish and wildlife productivity would be increased. Benefits are attributable to the net increase in harvest of these resources over the life of the project. This net increase in future harvests was then valued at current prices, adjusted for yearly fluctuations, and expressed in present value terms as of the base year of project life. Detailed benefit calculations are presented in Appendix F.

D.5.3. Although the quantity and quality of wetland habitat is responsible for a portion of the oyster benefits, other factors were considered as well. Estimates are that oyster production would increase by 100 percent with the proposed project in place. Oyster benefits would accrue beginning in the first year of project implementation, gradually rising to a 100 percent increase in productivity by the 5th year of salinity management. The 100 percent increase in productivity

LITERATURE CITED

Baumann, R.J. and R.D. Adams. 1981. The creation and restoration of wetlands by natural processes in the lower Atchafalaya River system: possible conflicts with navigation and flood control objectives. Center for Wetland Resources, Louisiana State University. Baton Rouge.

Wicker, K.M. 1980. Mississippi Deltaic Plain Region ecological characteristics: a habitation mapping study. US Fish and Wildlife Service, Office of Biological Services. FWS/OBS-79107.

menhaden, and other finfish and crustaceans is expected to exceed $5.3 million. Freshwater introduction into the Barataria Basin is expected to produce an annualized increase in commercial harvests of shrimp, oysters, menhaden, and other finfish and crustaceans valued at over $7.6 million.

The project-related reduction in marsh loss will also benefit wildlife populations and associated sport and commercial uses. Improved habitat quality and reduced rates of habitat loss in the Breton Sound Basin will increase wildlife population sizes and days of hunting opportunity above present levels. In the Barataria Basin, wildlife populations and hunting opportunities in the future with-project condition will be lower than at present, but will be significantly higher than that expected in the future without-project condition. In the Breton Sound Basin an average annual increase in the net value of fur animal and alligator harvests of $138,000 and $96,000, respectively, is expected. In Barataria Basin average annual increases of $90,000 and $85,000, respectively, are expected in fur annual and alligator harvest.

Nearly 96 percent of the benefits of the TSP are attributable to commercial fisheries. Applicable laws and regulations allow 100 percent Federal funding of the first costs of commercial fishery enhancement projects if operation, maintenance and replacement costs are assumed by non-Federal interests or a Federal fisheries agency. The TSP clearly, then, meets the requirements for full Federal funding of first costs. The TSP could be implemented as a mitigation measure to offset the role of the Mississippi River levees in increasing coastal wetland loss rates. Cost sharing for mitigation of fish and wildlife losses associated with Federal water resources projects is the same as for the project purpose causing the damages. The river levees constructed under the Mississippi River and Tributaries project authority for flood control are a totally Federal responsibility; therefore, the total costs for mitigation would also be a Federal responsibility under this cost sharing scenario. Another approach is to have the State of Louisiana assume 25 percent of the project costs, using Louisiana's Coastal Environmental Protection Trust Fund authorized by Act 41 of the Louisiana Legislature, with the Federal government assuming 75 percent of the project costs. This approach fails to recognize the need to mitigate the effects of the Mississippi River levees, but would preclude placing a financial burden on local governments. It is the position of the FWS that the TSP should receive full Federal funding, under either the commercial fisheries enhancement scenario or the mitigation scenario.

The FWS recommends that the following measures be implemented in the interest of fish and wildlife conservation:

1. The TSP be recommended for authorization in the final feasibility report;

2. The first costs of the proposed project features be borne totally by the Federal government;

3. The final feasibility report request authority for funding of post-authorization studies to include participation of the FWS, the Louisiana Department of Wildlife and Fisheries, and the National Marine Fisheries Service in the detailed design of the proposed structures, the development of operational and maintenance guidelines, the design of pre- and post-construction monitoring studies of the areas to be affected, and the formulation of water management plans for the affected areas;

4. The final feasibility report request (a) authority to secure sufficient land easement and/or title to allow for future enlargement of the proposed structures and (b) authority for enlargement of the proposed structures if, in the opinion of the District Engineer, such action would be justified to maximize project benefits; and

5. The final feasibility report recommend authorization for provision of bank fishing facilities along outflow channels near the proposed diversion structures, and public boat launching ramps at locations in the study area identified during post-authorization studies.

INTRODUCTION

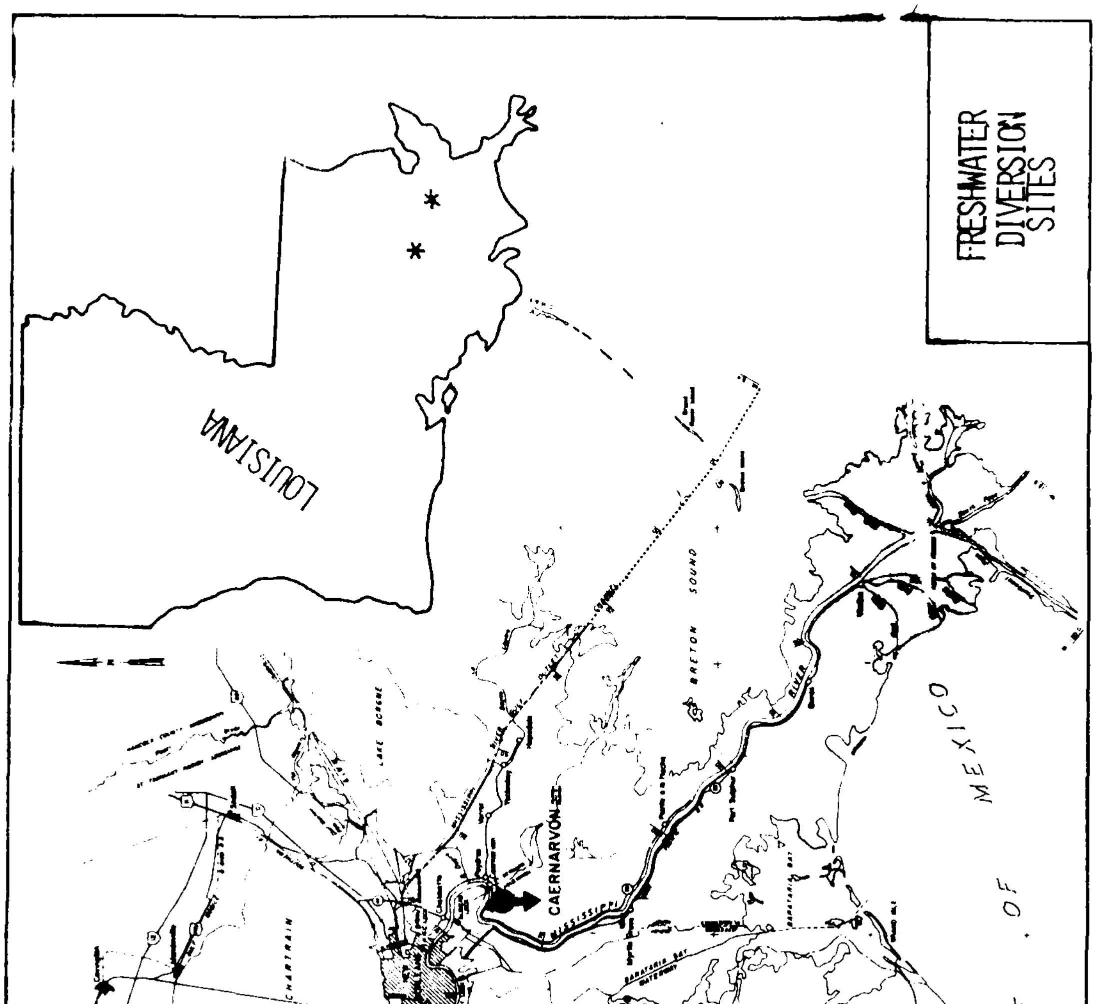
The Louisiana Coastal Area Study is being conducted under the leadership of the New Orleans District, Corps of Engineers (NODCE). The study was authorized by resolutions of the Committees on Public Works of the United States Senate and House of Representatives, adopted on April 19, 1967, and October 19, 1967, respectively. Those resolutions authorized investigations to determine the advisability of improvements or modifications of existing works in the Louisiana coastal area in the interest of hurricane protection, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and related water resource purposes.

A number of broad studies have been conducted to provide basic information on the important factors affecting water, marsh, and land areas in the Louisiana coastal zone; to identify problems and determine their seriousness and urgency; and to develop possible solutions. One of the findings of those and other studies was that the sub-delta marshes of the area are experiencing rapid erosion, subsidence and salinity increases, to the detriment of fish and wildlife. Introduction of fresh water from the Mississippi River has been identified as the best solution to this problem and candidate diversion sites have been proposed. A feasibility-grade evaluation of several of these candidate sites has been conducted. This report provides an analysis of the effects, on fish and wildlife, of tentatively recommended freshwater diversion sites and provides recommendations regarding operation of the freshwater diversion structures; this report fulfills the Fish and Wildlife Service's responsibilities under provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

PROJECT DESCRIPTION

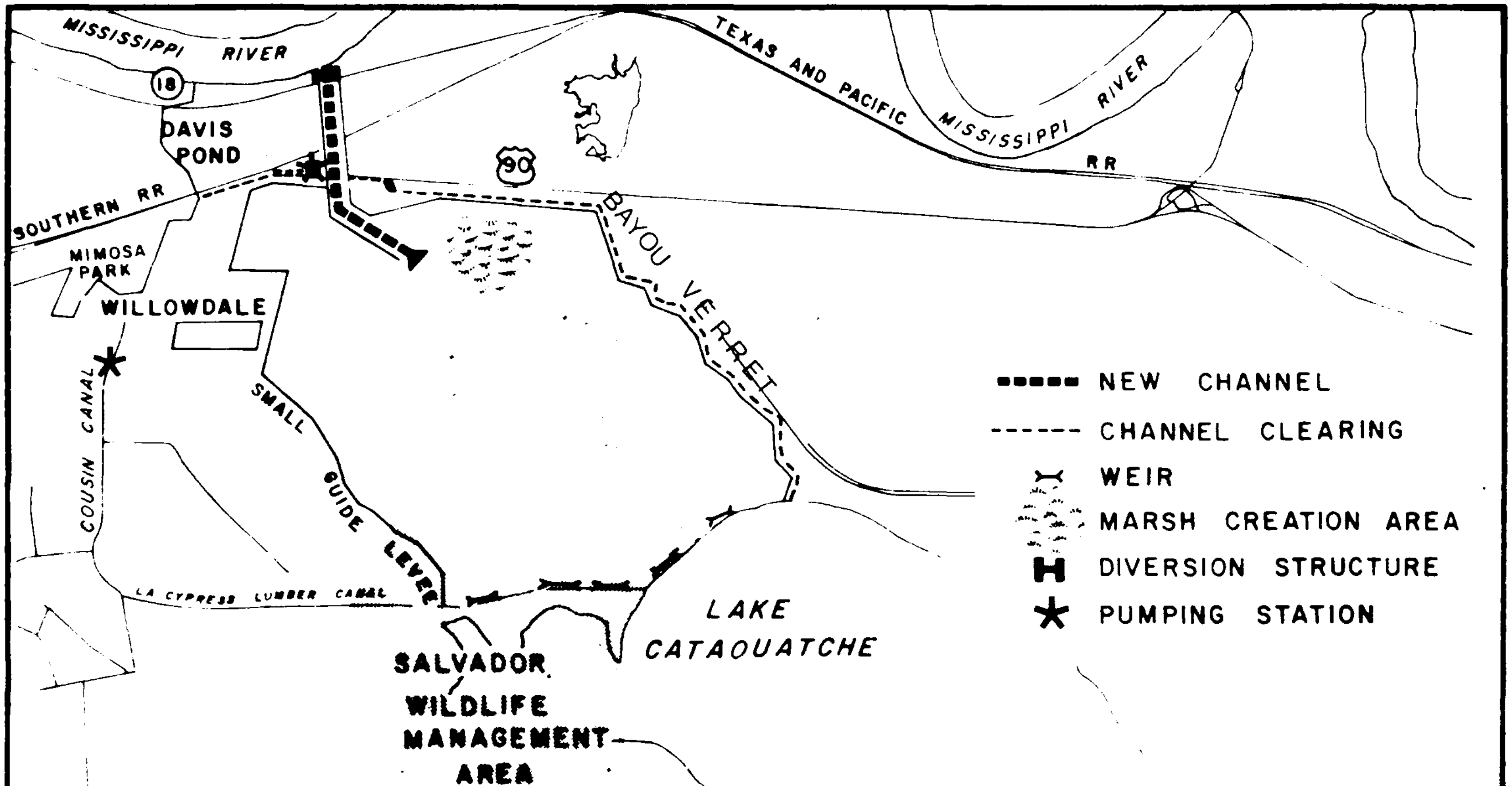
The tentatively selected plan includes diversion of Mississippi River water into the Barataria Basin and the Breton Sound Basin via structures at two locations, Davis Pond and Caernarvon (Figure 1).

Davis Pond Site - This site would have a structure capable of diverting a maximum flow of 10,650 cubic feet per second (cfs) through a series of gated box culverts located in the right descending bank of the Mississippi River, at mile 118.4 Above Head of Passes (AHP), near Mimosa Park in western St. Charles Parish (Figure 2). The water would enter the diversion structure via a 520-foot-long inflow channel having a bottom width of 200 feet and side slopes of 1 vertical on 3 horizontal. The diverted water would then flow through a 2.1-mile-long outlet channel (200-foot bottom width) to a series of marsh ponds north of Lake Cataouatche and thence through the remainder of the Barataria Basin (Hydrologic Unit IV). The diversion structure would be comprised of six 240-foot-long box culverts, each measuring 15 feet by 15 feet. The outflow channel would be bordered by guide levees having a crown elevation ranging from 3 to 6 feet National Geodetic



FRESHWATER DIVERSION SITES

FIGURE 1



RIGHTS OF WAY, WIDTH AND LENGTH

ITEM		LENGTH FEET	MAXIUM DISIGN FLOW (FEET) 10,650 WIDTH (FEET)
REACH A	INLET CHANNEL	520	400'
REACH A	OUTLET CHANNEL TO SOUTHERN PACIFIC RAILROAD	2,950	400'
	OUTLET CHANNEL TO US HWY 90	1,800	500'
REACH B	OUTLET CHANNEL TO IMPOUNDMENT	5,700	330'
	WEST GUIDE LEVEE	36,960	100'
	EAST GUIDE LEVEE	20,400	150'

LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

DIVERSION SITE, DAVIS POND
MI 118.4 AHP

U S ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
MARCH 1985 FILE NO

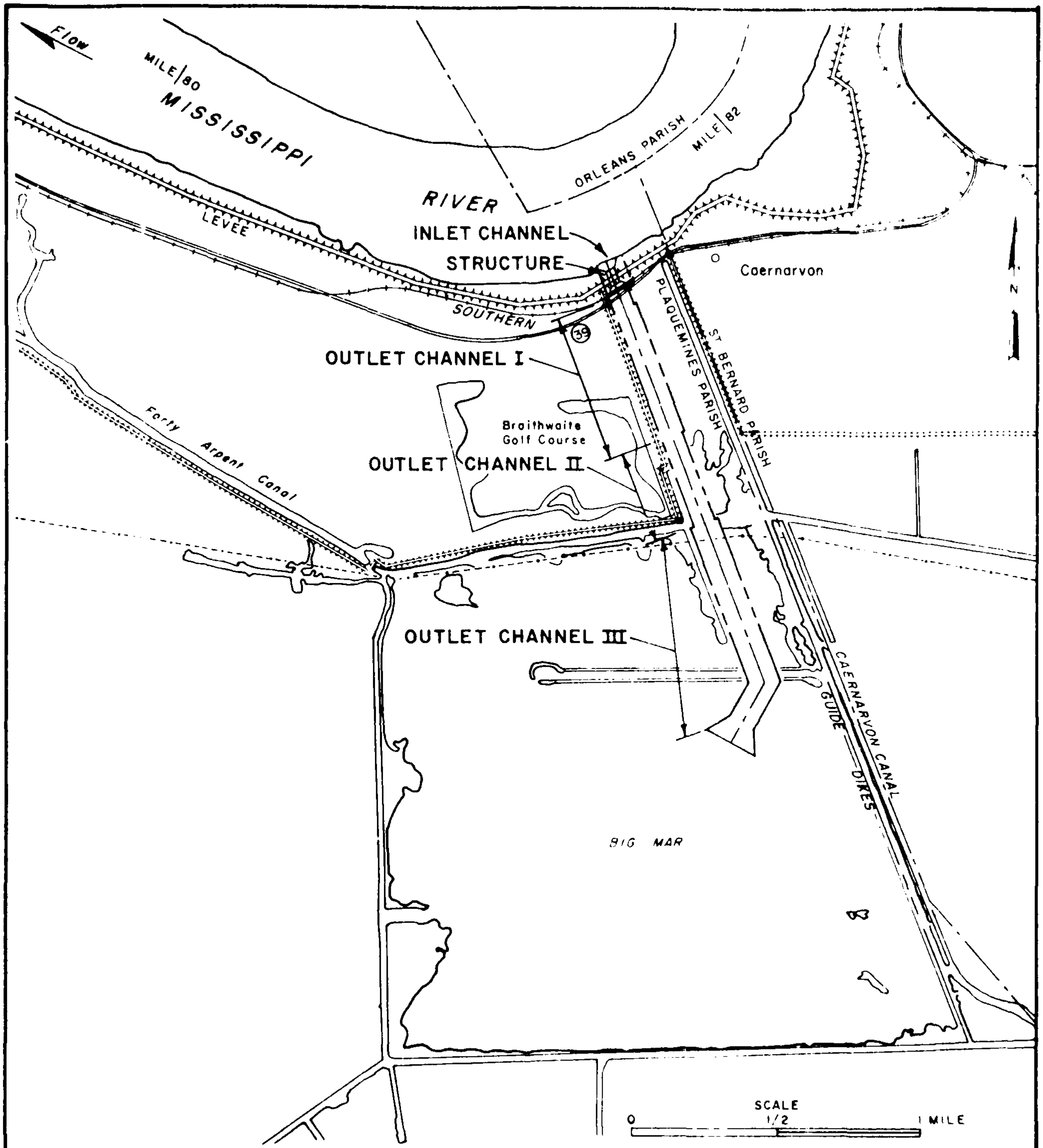
FIGURE 2

Vertical Datum (NGVD) and a crown width of 10 feet. Dredged material would be deposited along the channel and shaped to form the guide levees; excess spoil would be placed in shallow open water areas in an attempt to create 175 acres of marsh.

In order to minimize possible conflicts with existing drainage facilities serving residential developments in the area, a new drainage canal 4,000 feet long and 5 feet wide would be excavated along the east side of Willowdale Boulevard. A pumping station would be installed at the intersection of the new drainage canal and an access canal south of U.S. Highway 90, and an additional pump with a capacity of 100 cfs would be added to the existing St. Charles Parish pumping station on Cousin Canal. The plan also calls for clearing and snagging of 7.9 miles of area drainage canals. The diverted water would be directed into a 7,425-acre overflow area bordered by 13.3 miles of guide levees. Outflow from this overflow area would be over five weirs; these weirs would each be 250 feet long and would have an elevation of 2 feet NGVD with a low sill elevation of minus 3 feet NGVD.

Big Mar Site - This site, also known as the Caernarvon Site, would have a structure capable of diverting a maximum flow of 6,600 cfs through a series of gated box culverts located in the left descending bank of the Mississippi River, at mile 81.5 AHP, just downstream from the town of Caernarvon in extreme northern Plaquemines Parish (Figure 3). The water would enter the diversion structure via an 800-foot-long inflow channel having a bottom width of 200 feet and side slopes of 1 vertical on 3 horizontal. The diverted water would then flow through a 1.5-mile-long outlet channel (180-foot bottom width) into Big Mar, an unsuccessful wetlands drainage project that is now comprised of about 2,000 acres of shallow open water. After entering Big Mar, the diverted water would be allowed to exit into adjacent canals and flow throughout the Breton Sound estuary (Hydrologic Unit II). The diversion structure would be comprised of nine 100-foot-long box culverts, each measuring 5 feet by 20 feet. A two-mile-long dike with a 5-foot-wide crown would be built along the west bank of Caernarvon Canal to prevent diverted flows from entering the canal; the elevation of the dike would be 3 to 5 feet NGVD. Dredged material will be deposited on a 45-acre disposal site adjacent to the outflow channel.

Operation and Maintenance - The operation of the proposed structures would depend on the need to supplement rainfall with diverted river water in order to maintain desired salinities during April through September. During a normal 10-year rainfall cycle, heavy rainfall occurs 3 years in 10; little or no diversion would be required during those years. Substantial diversion of river water would be required, on the average, 7 of the 10 years of the typical rainfall cycle. As drought years normally occur only 1 year in 10, peak flows of 10,650 cfs at the Davis Pond Site and 6,600 cfs at Big Mar would be required only during that 10-percent drought year. In the 6 years (of the average 10-year rainfall cycle) when moderate rainfall would occur, diversion rates would range between 3,000 and 9,400 cfs at Davis Pond and between 1,800 and 5,800 cfs at Big Mar.



RIGHTS OF WAY, WIDTH AND LENGTH

ITEM	LENGTH (ft)	MAXIMUM DESIGN FLOW (cfs) 6600	4400 WIDTH (ft)	2200
INLET CHANNEL	800	449	347	295
OUTLET CHANNEL I	2550	415.5	317	247
OUTLET CHANNEL II	1750	342	263	258
OUTLET CHANNEL III	3800	460	344	258

LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION

DIVERSION SITE NEAR CAERNARVON

ARMY ENGINEER DISTRICT NEW ORLEANS, LA
ORPS OF ENGINEERS

APR [illegible] 98[illegible] FILE NO H 2 29437

FIGURE 3

The day-to-day operation of the diversion structures would be guided by a comprehensive monitoring system designed to gather hydrological, water quality, and biological data from a network of sampling stations. Present plans call for a three-phase monitoring program: pre-construction, post-construction, and long-term. The 3-year preconstruction monitoring phase will supplement available data and allow measurement of baseline conditions. Post-construction monitoring will be conducted for four years to permit assessment of the proposed diversion on hydrology, water quality, and fish and wildlife populations; that program will also provide data needed to design the long-term monitoring program. The long-term monitoring system will involve a network of sampling stations at which necessary hydrological, water quality, and biological data will be collected. The pre-construction and post-construction monitoring programs will cost $4,380,000; this amount is included in the first cost of the tentatively selected plan. The cost of the long-term monitoring program ($255,000, annually) is included in the operation and maintenance cost estimate. The NODCE and the non-Federal assuring agency will establish an interagency advisory group to design and carry out the monitoring programs; the advisory group will be comprised of representatives of Federal, State and local agencies with expertise in water quality, fish and wildlife, water supply, navigation, and flood control.

The operation, maintenance and replacement costs for the proposed diversion structures are estimated at $455,000, annually. This expenditure would include major structure repair once every 15 years, implementation of the monitoring program, annual maintenance dredging of 19,800 cubic yards of sediment from the conveyance channels, major maintenance of levees in the 2nd, 3rd, 5th, 10th, and 20th year, and other minor operation and maintenance costs during the 50-year life of the project. A summary of the annual benefits and costs for the proposed diversion structures is shown in Table 1.

AREA SETTING

Introduction

The area to be impacted by the proposed diversion sites lies within the Mississippi Deltaic Plain Region of southeastern Louisiana and is included in Hydrologic Units II and IV, generally as defined by Chabreck (1972). The inland limits of these units generally consist of the 5-foot m.s.l. elevation contour, while the seaward limits include the open waters of the Gulf of Mexico just beyond the barrier islands. Hydrologic Unit II is generally bounded by the Bayou La Loutre ridge and the Mississippi River-Gulf Outlet on the north and northeast, and by the Mississippi River levee on the west and southwest. This unit encompasses the open waters of Breton Sound. Breton Island, located at the seaward limit of Breton Sound, is part of the Chandeleur Islands barrier complex. Hydrologic Unit IV (Barataria Basin) is bounded by the Bayou Lafourche ridge on the west and the Mississippi River levee on the north and east. Barrier islands separate the seaward portion of the Barataria Basin from the

Table 1. Summary of Annual Benefits and Costs[1]

	First Cost	Annual Cost	Average Annual Benefits: Commercial Fishing & Wildlife	Recreation	Total	B/C Ratio
			(Thousands)			
Barataria Basin	$35,500	$3,500	$9,450	$260	$9,710	2.8 to 1
Breton Sound	$15,300	$1,470	$5,740	$310	$6,050	4.1 to 1
TOTAL	$50,800	$4,970	$15,190	$570	$15,760	3.2 to 1

1. U.S. Army Corps of Engineers (1984).

Gulf of Mexico; these include Grand Isle, Grand Terre Islands, Lanaux Island and adjacent unnamed barrier islands. Major habitats include bottomland hardwood forest, wooded swamp, fresh to saline marsh, and associated fresh to saline water bodies. The major navigation channels in the area include the Mississippi River, the Gulf Intracoastal Waterway, the Barataria Bay Waterway, and the Mississippi River-Gulf Outlet. The study area boundaries are shown in Figure 4.

Three wildlife management areas operated by the Louisiana Department of Wildlife and Fisheries (LDWF) are located in the study area. These include Bohemia Wildlife Management Area (WMA), Salvador WMA, and Wisner WMA. Bohemia WMA is located about 4 miles south of East Pointe a La Hache in central Plaquemines Parish. This 33,000-acre area is owned and leased by the Orleans Levee Board and managed by the LDWF. Habitat types on the WMA range from bottomland hardwoods along the natural levee of the Mississippi River to saline marsh and associated open water near the seaward limits of the area. Salvador WMA is located along the northwestern shore of Lake Salvador and the western shore of Lake Cataouatche about 12 miles southwest of New Orleans in St. Charles Parish. This 31,000-acre WMA is owned by the LDWF, and consists of predominantly fresh to intermediate marsh and associated shallow ponds. Forested wetlands (primarily wooded swamp) within the Salvador WMA occur along Bayou Bois Piquant. Wisner WMA is located about 12 miles south of Leeville in southern Lafourche Parish. This WMA comprises approximately 21,600 acres; it is owned by the Wisner Donation Foundation and operated by the LDWF. The area is predominantly brackish to saline marsh interspersed with canals, ponds, and lakes. Cheniers (relict beach ridges) supporting live oaks and other woody vegetation occur in the southern portion of the area. Low dunes are found along the Gulf beaches which form the southern boundary of the area.

Breton Island comprises a portion of Breton National Wildlife Refuge, which was established in 1904 and is managed by the U.S. Fish and Wildlife Service (FWS). Breton Island is actually two adjacent islands with a combined length of about 3 miles and a width of less than 1 mile. The islands support sand and sand/shell beaches on their gulf shores, backed by low sand dunes. The lower protected portion of the islands support black mangrove thickets and saltmarsh.

Description of Habitats

The existing and projected future without-project acreages of vegetated wetland habitats found in the study area (Hydrologic Units II and IV) are shown in Tables 2 and 3, respectively. The methodology used in projecting future without-project acreages was developed jointly by NODCE and FWS, and is discussed in Appendix D of the NODCE Feasibility Report (FR).

It should be noted that the marshes and adjacent natural levees in the study area are the products of deposition of riverborne sediments transported down the Mississippi River and deposited in shallow open water. Levee construction along the Lower Mississippi River, coupled with upstream diversion, bank stabilization and reservoir construction, has greatly reduced freshwater and sediment transport to

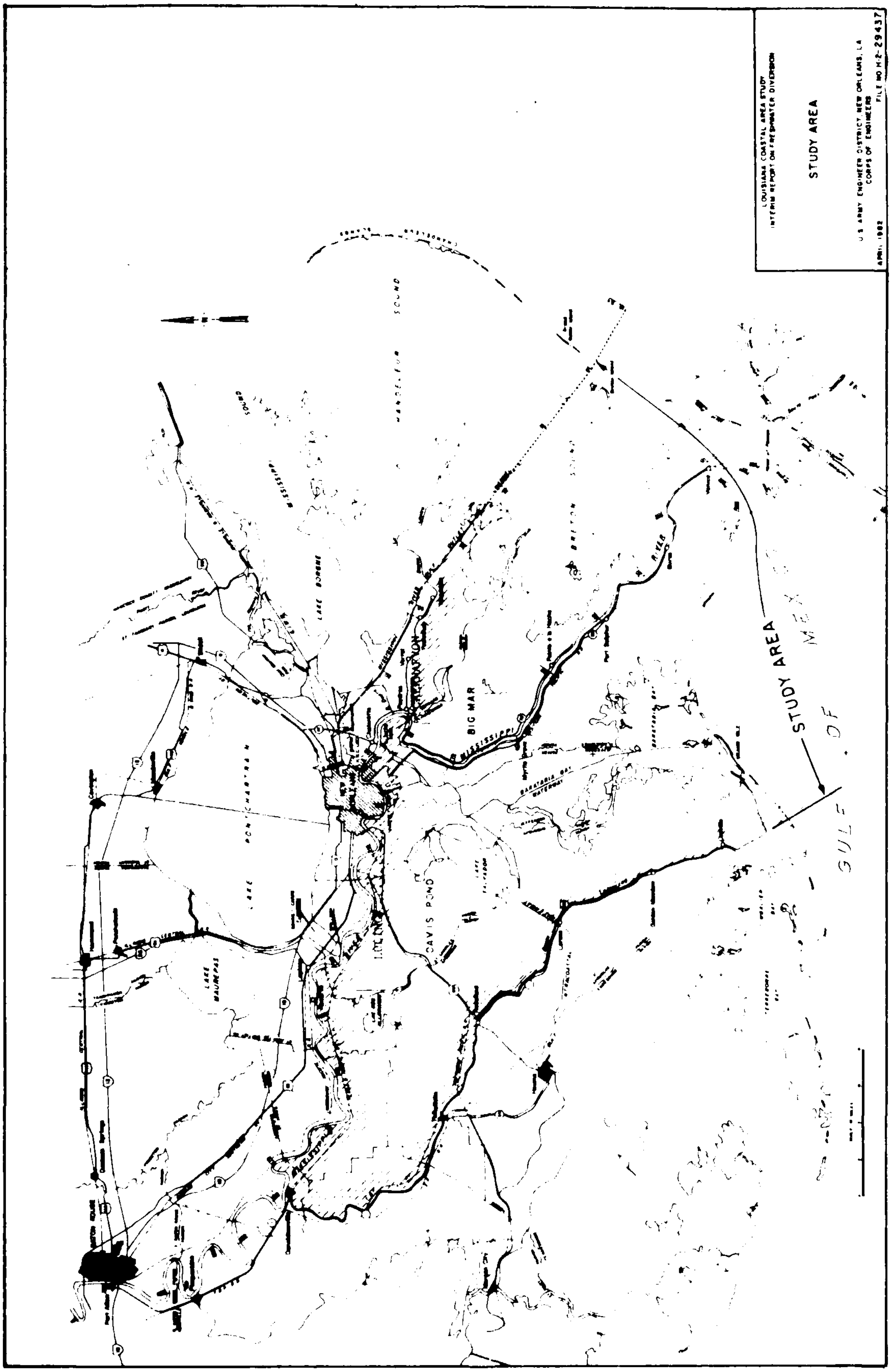

LOUISIANA COASTAL AREA STUDY
INTERIM REPORT ON FRESHWATER DIVERSION
STUDY AREA
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA
CORPS OF ENGINEERS
APRIL 1982
FILE NO H-2-29437
STUDY AREA
BIG MAR
DAVIS POND
LAKE BORGNE

FIGURE 4

. Existing (1978) and future without-project wetland habitat acres in the Breton Sound Basin (Hydrologic Unit II), Louisiana Coastal Area

t Type	1978	1985	1995	2005	2015	2025	2035
land Hardwoods	9,479	8,527	7,331	6,303	5,419	4,659	4,005
Swamp	1,006	905	778	669	575	494	425
Intermediate Marsh	13,595	11,072	8,258	6,159	4,593	3,426	2,555
sh Marsh	131,257	130,538	128,318	125,052	121,051	116,546	111,724
Marsh	46,766	41,329	34,641	29,035	24,335	20,397	17,096
Marsh	191,618	182,939	171,217	160,246	149,979	140,369	131,375

3. Existing (1978) and future without-project wetland habitat acres in the Barataria Basin (Hydrologic Unit IV), Louisiana Coastal Area

t Type	1978	1985	1995	2005	2015	2025	2035
land Hardwoods	43,470	39,947	35,404	31,378	27,810	24,647	21,844
Swamp	169,774	155,989	138,249	122,249	108,593	96,243	85,298
Intermediate Marsh	196,647	164,002	124,538	97,632	75,330	58,122	44,845
sh Marsh	111,661	114,422	113,465	108,471	100,891	91,788	81,926
Marsh	157,489	152,059	144,625	137,554	130,829	124,443	118,349
Marsh	465,797	430,483	384,628	343,657	307,050	274,343	245,120

the study-area wetlands. Reduced freshwater inflow and extensive canal dredging has led to saltwater intrusion into the study area. The net result of these factors has been accelerated subsidence and erosion of marshes and swamps and a conversion to more saline vegetation types or open water.

Recent studies (Wicker 1980) have shown that the acreage of marsh located roughly in that portion of Hydrologic Unit IV (Barataria Basin) south of Lac Des Allemands declined from 532,500 acres in the mid-1950's to 406,000 acres in 1978, a reduction of nearly 24 percent. An even more dramatic reduction was documented for the fresh marsh category, which declined from 263,500 acres in the mid-1950's to 48,000 acres in 1978, a reduction of nearly 82 percent. Wicker (1980) aggregated Hydrologic Units I and II into a single unit for reporting the results of wetland mapping studies. Therefore, separate wetland acreage data for the Hydrologic Unit II portion of the study area were not readily available. However, an analysis of data for the Plaquemines Parish portion of that unit, which contains the bulk of Hydrologic Unit II, reveals that total marsh acreage declined from 164,000 acres in the mid-1950's to 132,100 acres in 1978. This represents a reduction of 31,900 acres or approximately 19.5 percent. Fresh marsh declined from 25,200 acres in the mid-1950's to approximately 3,000 acres in 1978, a reduction of 88 percent. The rapid rate of marsh and forested wetland loss in the study area is expected to continue under future without-project conditions (Tables 2 and 3). The following is a general description of the various wetland habitats of the study area.

Bottomland Hardwoods

Bottomland hardwood forests are located along the natural levees of the Mississippi River and its abandoned distributaries which extend into the marshes. Portions of these forests are temporarily or seasonally flooded, and are classified as Palustrine Forested Wetlands (Cowardin et al. 1979). Common vegetation in these wetlands includes water oak, overcup oak, Nuttall oak, green ash, pumpkin ash, bitter pecan, red maple, mahaw, green hawthorn, water locust, and palmetto. Common species on higher grounds within this habitat type include live oak, hackberry, sweetgum, honeylocust, and deciduous holly.

Wooded swamp

This habitat type constitutes semipermanently flooded Palustrine Forested Wetlands (Cowardin et al. 1979), and is typically located inland from fresh marsh areas. Typical woody vegetation includes baldcypress, tupelogum, Drummond red maple, and buttonbush. Herbaceous vegetation includes duckweeds, alligatorweed, water hyacinth, swamp lily, and lizard's tail.

Fresh marsh

Typical fresh marsh (Palustrine Emergent Wetlands, Cowardin et al. 1979) vegetation includes maidencane, water hyacinth, pickerelweed, alligatorweed, and bulltongue. These marshes are found inland from the intermediate marshes.

Intermediate marsh

As indicated by the name of this marsh type, it is found in the transition zone between fresh and brackish marsh. Common vegetation includes saltmeadow cordgrass, deer pea, bulltongue, wild millet, southern bulrush, and sawgrass. The intermediate, brackish, and saline marsh types are considered Estuarine Emergent Wetlands (Cowardin et al. 1979).

Brackish marsh

This marsh is generally found at moderate salinities between the saline and intermediate marsh zones. Typical vegetation includes saltmeadow cordgrass, Olney's threesquare, and leafy threesquare.

Saline marsh

This marsh is generally found in areas exceeding 15 parts per thousand (ppt) average salinity. The most abundant plant species in this zone are saltmarsh cordgrass, saltgrass, saltwort, glasswort, and black rush. Black mangrove is frequently found in association with saltmarsh cordgrass, especially on the leeward side of barrier islands.

Open water

Open water areas include both freshwater and estuarine types. Fresh open waters include marsh ponds less than 20 acres in size (Palustrine Open Water, Cowardin et al. 1979) and lakes (Lacustrine Open Water, Cowardin et al. 1979) such as Lac Des Allemands and Lake Cataouatche. Salinities in fresh open waters usually do not exceed 0.5 parts per thousand (ppt). Estuarine open water (Estuarine Subtidal Open Water, Cowardin et al. 1979) includes the ponds, lakes, bays, and sounds where salinities usually exceed 0.5 ppt. In some cases, shallow open waters are dominated by plants that grow on or below the water surface. Such areas are termed Palustrine Aquatic Bed (Cowardin et al. 1979) in fresh areas, and Estuarine Aquatic Bed in estuarine open water areas. Common Palustrine Aquatic Bed vegetation includes water hyacinth, coontail, fanwort, and southern naiad. Widgeongrass is usually the dominant plant species in the Estuarine Aquatic Bed habitat type.

Barrier Islands

The barrier islands support sand and sand/shell beaches, low vegetated dunes, and tidal wetlands vegetated by black mangrove and saltmarsh cordgrass. Protected shallows found in association with these islands sometimes support beds of seagrasses, such as shoalgrass, turtlegrass, and manateegrass.

bles 10 and 11 provide a comparison of future without-project (FWOP) d future with project (FWP) acreages for the fresh-intermediate, ackish, and saline marsh types in Hydrologic Units II and IV, spectively. The fresh and intermediate marsh types were combined to the fresh-intermediate category because of the similarity of ldlife productivity of these two types, and because of the nature of e salinity projections provided by NODCE.

shown in Table 10, freshwater introduction into Hydrologic Unit II reton Sound Basin) would result in a net gain of total marsh when mpared to the FWOP condition. All of that gain would occur in the esh-intermediate marsh type; however, with net reductions occurring the brackish and saline marsh types. The decline in brackish marsh der FWP conditions would result from the conversion of this marsh pe to fresh-intermediate marsh. Similarly, reductions in salinity e expected to convert all saline marsh, not lost to subsidence and osion, to brackish marsh by the year 1995.

Hydrologic Unit IV (Barataria Basin), the primary freshwater scharge location would be far removed from the brackish marsh, and e shift in the 15 ppt isohaline will be much smaller than that recasted for the Breton Sound Basin. Thus, major shifts in the stribution of marsh types have not been projected. The primary fference in acreages (Table 11) of marsh types under FWOP versus FWP nditions, then, is attributable to reductions in the rate of marsh ss associated with the proposed freshwater diversion. Accordingly, t increases in all marsh types would be experienced.

e proposed plans for freshwater diversion would not directly benefit ther bottomland hardwoods or wooded swamp. The total acreage ables 2 and 3) of bottomland hardwoods in the study area is expected decline by over 50 percent within the next 50 years due primarily clearing for agriculture and industrial and urban development. milarly, the total acreage (Tables 2 and 3) of wooded swamp in the udy area is projected to decline by nearly 50 percent over the next years; however, the proposed freshwater diversions may help to eserve and rejuvenate remaining baldcypress/tupelogum swamp in the per basins.

ring diversion at the Davis Pond site, water would be ponded to an erage depth of 2 feet in the semi-impounded 7,425-acre overflow ea, with water being deeper over the lower marsh areas and shallow absent on the higher ridge portions of the area. Although ponding uld adversely impact certain species of trees and shrubs which cupy higher, drier sites, typical swamp vegetation should not suffer verse impacts. According to Klimas et al. (1981), swamp and low dge species such as bitter pecan, buttonbush, swamp privet, green h, waterlocust, baldcypress, tupelogum, overcup oak, and Nuttall oak e quite water tolerant and can survive prolonged flooding for more an one year. The fact that most freshwater diversion will occur ring the months of January through May, most of which is a dormant riod for the tree species in the overflow area, further supports the lief that adverse impacts to the wooded swamp will not likely sult.

disposal, subject to applicable Federal and State permitting activities. In all likelihood, FWS would oppose the permitting of any proposal to drain that area.

Generally the direct adverse impacts on fish and wildlife resources, of construction and maintenance activities associated with the diversion structures, are viewed as minor compared with the anticipated beneficial impacts on the wetlands of the hydrologic units receiving the diverted waters. Accordingly, no detailed analyses of fish and wildlife impacts, associated with the habitat losses resulting from construction and maintenance, was performed.

Impacts Associated with Freshwater Diversion into the Marshes and Open Waters of the Receiving Areas

Habitat Impacts

The greatest beneficial impacts associated with these diversions would be a reduction in the alarming rate of marsh loss and the achievement of a more favorable salinity regime in the marshes and open waters of the study area. As previously noted, data presented by Baumann and Adams (1982) indicate a reduced rate of marsh loss in those areas under the influence of Atchafalaya River flows, compared to areas receiving little or no freshwater influence from that waterway. Several factors are believed to be responsible for this reduced rate of marsh loss in areas associated with riverine inflow.

Fine-grained sediments are transported by inflowing fresh water into marsh areas where these sediments settle out. As reported by Delaune et al. (1978), the entrapment and stabilization of suspended inorganic sediment by marsh vegetation is an important process which helps to maintain elevation with respect to sea level, i.e., helping to offset subsidence. Delaune et al. (1978) also noted that the incoming sediment also supplies nutrients for plants which subsequently enhance further entrapment and stabilization of sediments. Artificial enrichment of several species of marsh plants in coastal Louisiana with wastewater from a menhaden processing plant increased the growth of those plants by 30 to 51 percent (Payonk 1975). Increased plant production associated with increased nutrient inflow also contributes to peat formation. Thus, maintenance of a viable marsh is accomplished by the aggradational process of plant growth, accumulation of detritus, and inorganic deposition.

As Chabreck (1981) noted, the greatest damage to marsh plants in coastal Louisiana occurs when fresh marshes having highly organic soils are subjected to much greater water salinity and strong tidal action. Plants in these areas are killed by elevated water salinity, and the underlying organic substrate becomes loose and disorganized without the stabilizing effect of plant roots. When this occurs, organic soils are flushed from the affected areas, leading to replacement of emergent marsh with open ponds and lakes. Introduction of supplemental fresh water would greatly retard intrusion of salt water into fresh marsh areas, thus substantially reducing the loss of these wetlands.

: 9. Acreage of specific habitat types to be affected by construction and spoil disposal at Davis Pond and Big Mar freshwater diversion sites

	Habitat Acres				
	Bottomland Hardwoods	Wooded Swamp	Marsh	Water	Agricultural Land
is Pond le 118.4 AHP)	100	112	93 (Fresh)	215a/	36
Mar le 81.5 AHP)	22	6	16 (Intermediate)	70	0

175 acres of open water will be used as a dredged material disposal site for marsh creation.

that study and other pertinent references, estimates of project-related reductions in marsh loss were developed jointly by FWS and NODCE personnel. A detailed account of the methodology used to determine with-project and without-project habitat acres is contained in Appendix D of the FR prepared by NODCE.

The proposed freshwater diversions would also result in more favorable salinity conditions conducive to improved oyster production. In order to quantify project benefits to oyster production, meetings were held between representatives of FWS and NODCE, and LDWF personnel having special expertise in oyster biology. During these meetings, maps developed by NODCE displaying project-induced changes in isohalines were studied in order to assist in estimating project benefits to oyster production. A detailed explanation of the methodology used to develop estimates of project-related increases in oyster production is contained in Appendixes D and F which accompany the FR prepared by NODCE.

Field investigations of the project area were conducted by biologists with the FWS, NODCE, and LDWF to gain additional information regarding habitat types and associated fish and wildlife use in the study area. Knowledge obtained during these investigations was supplemented by interpretation of available aerial photography and habitat maps prepared for the Fish and Wildlife Service's National Coastal Ecosystems Team by Wicker et al. (1980).

PROJECT IMPACTS

Project impacts on fish and wildlife habitat quantity and quality can be divided into two major categories, i.e., habitat alteration associated with construction and maintenance of diversion structures and associated channels, and impacts of the proposed freshwater diversion on the marshes, open waters and associated productivity of the receiving areas.

Impacts Associated with Construction and Maintenance of Diversion Structures and Channels

A summary of the direct construction and maintenance impacts of each feature of the recommended plan is shown in Table 9. The Davis Pond site would impact the largest acreage (341 acres) of marsh, wooded swamp, bottomland hardwoods, and agricultural land; the Big Mar site would require only 44 acres of those habitat types. Although a total of 215 acres of open water would be impacted by construction at the Davis Pond site, 175 acres of that would be used as a dredged material disposal site for marsh creation. The additional 100-cfs-capacity pump added to the existing pumping station on Cousin Canal, at the request of St. Charles Parish, could facilitate the drainage of approximately 415 acres of wooded swamp located immediately west of the road to Willowdale subdivision. However, drainage of this area would likely require additional ditching and associated spoil

EVALUATION METHODOLOGY

An analysis of the impacts of the tentatively selected freshwater diversion features on fish and wildlife resources was performed in close cooperation with personnel of the NODCE Planning Division and the LDWF. This analysis dealt with two major types of impacts, i.e., the direct impacts on wildlife habitat associated with construction and maintenance of the diversion structures and associated channels and water management features, and the effects of introducing supplemental fresh water, sediment, and nutrients on salinity levels and marsh loss in the receiving area. An effort was made to quantify both monetary and non-monetary impacts of the proposed project on fish and wildlife resources.

Monetary impacts were assessed by predicting project effects on sport fishing, sport hunting, commercial fisheries, and commercial fur and alligator harvests. A habitat-based evaluation method which embodied the principal concepts and assumptions of FWS's Habitat Evaluation Procedures was utilized to assess project impacts on wildlife habitat quality and quantity. Details of the procedures used in the economic analysis are described in Appendix F of the FR prepared for this project by the NODCE. The methodology and findings of the habitat-based analysis are found in Appendix A of this report.

For both the economic and habitat-based analyses, the primary basis for assessing project impacts was a comparison of habitat quality and quantity under with-project versus without-project conditions. The 50-year project life was assumed to extend from 1985 to 2035. Because the proposed diversion features would affect the Breton Sound Basin and Barataria Basin (Hydrologic Units II and IV, respectively), existing and anticipated future habitat acreages were estimated for each of those units. Existing acreages (Tables 2 and 3) were derived primarily from data developed by Wicker (1980) and stored in computers by the FWS's National Coastal Ecosystems Team in Slidell, Louisiana. It was necessary to supplement these data with additional acreage information derived by planimetering topographic maps covering those portions of the study area that were not mapped in Wicker's study. Estimates of future without-project acreages were developed for selected major habitat types. These estimates were made for key target years spanning the 50-year project life, i.e., 1985 through 2035, and were based on the loss rates calculated from Wicker (1980) for the period 1955-56 through 1978.

The primary basis for computing project benefits to fish and wildlife was the project-related decrease in marsh loss. The proposed introduction of supplemental fresh water would reduce saltwater intrusion and associated deterioration of fresh and intermediate marshes, and would also introduce additional nutrients and sediments that would increase marsh plant growth and associated peat production and reduce subsidence rates. A recent study by Baumann and Adams (1982) indicated an extremely low rate of loss in marshes under direct influence of Atchafalaya River overflow, and an increasing rate of loss with increasing distance from that freshwater influence. Based on

A small colony of brown pelicans nest in the Queen Bess Island area in southern Barataria Bay. At least one nesting colony of these birds has been re-established on the Chandeleur Islands.

The Arctic peregrine falcon is an occasional visitor to the study area, occurring along the coast during the fall and spring migration.

Other Non-Game Species

Numerous other non-game species are present in the study area. These include seabirds, wading birds, shorebirds, songbirds, raptors, land and marine mammals, and numerous reptiles and amphibians. Detailed information on the location, species composition, and magnitude of wading bird and seabird nesting colonies in the study area is contained in a report by Keller et al. (1984). Common wading birds in the study area include great blue heron, little blue heron, black-crowned night heron, Louisiana heron, green heron, yellow-crowned night heron, great egret, cattle egret, snowy egret, reddish egret, white-faced ibis, and white ibis. Wading birds occur in the forested wetlands, marshes, and barrier islands of the study area. Seabirds present in the study area include brown pelican, white pelican, herring gull, laughing gull, ring-billed gull, gull-billed tern, least tern, Forster's tern, Caspian tern, royal tern, and black skimmer.

Common shorebirds in the study area include black-necked stilt, semi-palmated plover, killdeer, black-bellied plover, whimbrel, willet, greater yellowlegs, lesser yellowlegs, American oystercatcher, and sandpipers. These are common in marshes, along beaches and bay shores and/or on mudflats. Raptors commonly observed in the study area include red-tailed hawk, red-shouldered hawk, marsh hawk, American kestrel, and barred owl. Other representative non-game birds include prothonotary warbler, Carolina wren, cardinal, white-eyed vireo, robin, long-billed marsh wren, eastern kingbird, belted kingfisher, boat-tailed grackle, and red-winged blackbird.

Non-game mammals are numerous in the project area. The rice rat is common in the marshes of the project area, while the white-footed mouse, short-tailed shrew, eastern wood rat, and nine-banded armadillo are representative of forested lands. The Atlantic bottle-nosed dolphin is the most common marine mammal of the study area, found primarily in the bays, sounds, tidal passes, and adjacent gulf waters.

Reptiles present in the marshes and swamps of the study area include the American alligator, common snapping turtle, alligator snapping turtle, smooth softshell turtle, spiny softshell turtle, red-eared turtle, stinkpot, green anole, broad-headed skink, diamondback water snake, banded water snake, Gulf salt marsh snake, and western cottonmouth. Common amphibians include bullfrog, pig frog, bronze frog, leopard frog, lesser siren, gulf coast toad, green tree frog, squirrel treefrog, and cricket frog. Of the above-listed species, only the diamondback terrapin and the Gulf salt marsh snake are common in the brackish to saline marshes of the study area.

Table 8. Value of potential alligator harvest by marsh type in Hydrologic Units II and IV, Louisiana Coastal Area a/

	Marsh Type		
	Fresh-Intermediate	Brackish	Saline
Mean harvest (hides/acre)			
Unit II (Breton Sound)	0.0050	0.0032	negligible
Unit IV (Barataria Basin)	0.0075	0.0038	"
Mean value/hide b/	$140.00	$140.00	N/A
Mean value of meat/animal c/	$75.21	$75.21	N/A
Mean total value/animal	$215.21	$215.21	N/A
Total value (gross)/ acre			
Unit II	$1.08	$0.69	negligible
Unit IV	$1.61	$0.82	"
Net value (gross value less cost of harvest/ acre d/			
Unit II	$0.81	$0.52	negligible
Unit IV	$1.21	$0.62	"

a/ Data on hide value, mean hide length, mean weight, and harvest provided by Ted Joanen and David Richard, Louisiana Department of Wildlife and Fisheries, Grand Cheniere, Louisiana.

b/ Based on mean length/hide of 7 feet and mean 1983 hide price of $20.00 per linear foot.

c/ Based on mean dressed weight/animal of 47.6 pounds and estimated 1983 mean price of $1.58 per pound.

d/ Based on cost of harvest equal to 25 percent of total gross value.

Table 7. Fur catch and value by marsh type for coastal Louisiana

Species	Marsh Type: Fresh-Intermediate	Brackish	Saline
Muskrat			
Average catch/acre a/	0.0880 b/	0.0844	0.0169c/
Value/pelt d/	$5.70	$5.70	$5.70
Value/acre	$0.5015	$0.4811	$0.0963
Nutria			
Average catch/acre	0.3988b/	0.0864	insignificant
Value/pelt	$7.76	$7.77	-
Value/acre	$3.0940	$0.6703	insignificant
Mink			
Average catch/acre	0.0015 b/	0.0011	insignificant
Value/pelt	$14.36	$14.36	-
Value/acre	$0.0215	$0.0158	insignificant
Otter			
Average catch/acre	0.0005 b/	0.0002	insignificant
Value/pelt	$46.80	$46.80	-
Value/acre	$0.0234	$0.0094	insignificant
Raccoon			
Average catch/acre	0.0093 e/	0.0078 f/	insignificant
Value/pelt	$12.03	$12.03	-
Value/acre	$0.1119	$0.0938	insignificant
Total			
Average catch/acre	0.4979	0.1799	0.0169
Gross value/acre	$3.75	$1.27	$0.0963
Net value/acre g/	$2.82	$0.96	$0.07

a/ Average catch per acre, unless otherwise noted, from Palmisano (1973).

b/ Represents mean of fresh and intermediate marsh average harvest/acre reported by Palmisano (1973).

c/ Calculated as 25 percent of brackish marsh average harvest/acre reported by Palmisano (1973).

d/ Based on 1976-81 running average of prices received by the trapper, expressed in 1983 dollars using the Consumer Price Index for Hides, Skins, Leather and Related Products. Base price data compiled by Louisiana Department of Wildlife and Fisheries.

e/ Represents one half of the combined maximum production for fresh and intermediate marsh types reported by Palmisano (1973).

f/ Represents one half the maximum value reported by Palmisano (1973).

g/ Cost of harvest equals 25 percent of gross returns; net value equals gross returns minus cost of harvest.

Table 6. Estimated 1978 sport hunting use (man-days) in Hydrologic Units II and IV of Coastal Louisiana a/

Hunting Type	Hydrologic Units II	Hydrologic Units IV
Deer	394	5,703
Small game b/	20,968	52,075
Waterfowl	57,747	141,565
Other marsh birds c/	38,924	98,334
Total	118,033	296,677

a/ Data compiled by New Orleans District Corps of Engineers' Recreation Section.

b/ Primarily rabbit, squirrel, and bobwhite.

c/ Primarily rails and snipe.

The white-tailed deer is the only big game mammal found in the study area. It is found in bottomland hardwood forests and wooded swamps, and also occurs in the coastal marshes, especially in the fresher marshes interspersed with higher ground (i.e., natural levees and spoil banks).

Small game mammals present in the study area include swamp rabbit, eastern cottontail, gray squirrel, fox squirrel, and raccoon. Swamp rabbits most commonly occur in the wooded swamps, bottomland hardwoods and fresh to brackish marshes of the study area. The eastern cottontail is most frequently found in association with pastures, row crop fields, along fence rows and drainage ditches, and forest edges. Both the gray and fox squirrels occur in the wooded swamp and bottomland hardwood forests of the study area. Raccoon are found in both of these forest types, and also range into the coastal marshes of the study area.

Table 6 shows the estimated 1978 demand for sport hunting in the study area. As shown in that table, waterfowl hunting is the most popular hunting activity, while deer hunting supports the smallest amount of use.

Commercial Species

The marshes and forested wetlands of the study area support a variety of commercially important furbearers. The most important of these include the nutria, muskrat, raccoon, mink, and river otter. Table 7 provides a summary of the average per-acre harvest and value of these species by marsh type in coastal Louisiana. Other fur animals present in the study area include red fox, gray fox, bobcat, beaver, and opossum. Most of these species are found in forested areas, and may venture into adjacent open lands. The opossum is also a common marsh resident when higher ground is located nearby.

Because of changes in regulations developed pursuant to the Endangered Species Act of 1973, controlled sport and commercial hunting of the American alligator is now allowed in the study area. The sale of hides and meat represents an important new source of income for local residents. The alligators in the study area are now classified as threatened under the Similarity of Appearance clause of the Endangered Species Act of 1973. Table 8 presents the value of the potential alligator harvest in the various marsh types of the study area.

Endangered Species

Species other than the American alligator which are present in the study area and protected under provisions of the Endangered Species Act include the brown pelican, bald eagle, and Arctic peregrine falcon. The bald eagle is associated with the marshes, swamps, and adjacent lakes of the study area from early fall to late spring. Six recently active bald eagle nests are found in the study area, with most of the nests found between Lac Des Allemands and Lafitte.

area. Wood ducks nest in the wooded swamps and seasonally-flooded bottomland hardwood forests of the study area, and additional migrants winter in these habitats. Mottled ducks nest in the fresh to saline marshes of the area. Diving ducks which winter in the study area include ring-necked duck, lesser scaup, hooded merganser, red-breasted merganser, bufflehead, redhead, and canvasback. Diving ducks are generally most common in bays, sounds, and larger marsh ponds and lakes. The largest wintering concentration of redheads in the study area is usually found among the seagrass beds located along the Chandeleur Islands.

For the past few years, the FWS, in cooperation with State fish and wildlife agencies and other knowledgeable individuals, has been identifying key privately-owned wetland areas along the Central Gulf Coast that are considered vital habitat for wintering waterfowl. Ten of the 14 key wetland units identified along the Central Gulf Coast are located in coastal Louisiana; portions of two of these, i.e., the Delacroix Unit and the Terrebonne Unit, are located in the study area.

The Delacroix Unit, located in Hydrologic Unit II, is bordered by Lake Borgne and the Mississippi River-Gulf Outlet on the northeast, Breton Sound to the southeast, and the Mississippi River levee on the southwest and northwest sides. The Delacroix Unit was once considered to be southeast Louisiana's most productive fur and waterfowl marsh area, but now supports the smallest population of wintering waterfowl of all the key wetland areas in Louisiana. Between 1969 and 1978, this unit supported an average annual population of 19,200 wintering waterfowl. The drastic decrease in wintering waterfowl in the Delacroix Unit during recent years is attributed to rapid conversion of fresh and intermediate marshes to brackish and saline marshes, much of it resulting from saltwater intrusion associated with construction of the Mississippi River-Gulf Outlet.

The Terrebonne Unit is ranked first among the 14 key wetland units in the Central Gulf Coast region; less than half of this unit is located in the Hydrologic Unit IV portion of the study area. That portion is generally bordered on the west by Bayou Lafourche and on the east by Lac Des Allemands, Bayou Des Allemands, Bayou Perot and Little Lake; it encompasses virtually all of the wetlands in this area north of the latitude of Golden Meadow. During the period 1969-1978, the Terrebonne Unit hosted an average of nearly 403,000 wintering waterfowl per year, with the fresh marshes in this unit supporting 87 percent of this total.

Lesser snow geese are the only geese which winter in the study area in significant numbers. These are usually found in brackish marshes supporting three-cornered grass (<u>Scirpus olneyi</u>), such as is found in the St. Bernard sub-delta.

Other marsh birds important as game species include common gallinule, purple gallinule, king rail, clapper rail, and the common snipe. The American woodcock winters in the wooded swamps and bottomland hardwood forests, while the mourning dove and bobwhite are most often associated with agricultural fields and forest edges in the study area.

Table 5. Average annual commercial harvest a/ and value of major estuarine dependent finfishes and shellfishes attributable to Hydrologic Units II (Breton Sound Basin) and IV (Barataria Basin), Louisiana Coastal Area

Species	Hydrologic Unit II b/	Hydrologic Unit IV
Menhaden		
Harvest c/	11.75	225.81
Value d/	0.70	13.55
Shrimp		
Harvest	7.04	23.23
Adjusted Harvest e/	13.06	42.26
Value	14.89	48.18
Oyster		
Harvest	2.50	4.05
Adjusted Harvest f/	6.26	10.13
Value	9.76	15.80
Croaker g/		
Harvest	1.05	15.25
Value	0.24	0.92
Blue Crab		
Harvest	1.25	3.56
Value	0.42	1.21
Seatrout g/		
Harvest	0.36	2.70
Value	0.23	0.49
Spot g/		
Harvest	0.01	2.88
Value	--	0.14
Red Drum		
Harvest	0.18	0.36
Value	0.09	0.17
Total		
Harvest	24.14	277.84
Adjusted Harvest	33.92	302.95
Value	26.33	80.46

SOURCE: National Marine Fisheries Service landing records for the years 1963-1978, compiled by New Orleans District, Corps of Engineers.

a/ Harvest refers to total recorded commercial catch of a particular species from an area. The catch from offshore waters was assigned to inshore areas based on the relative abundance of estuarine marsh habitat.

b/ Catch from Chandeleur and Breton Sounds was disaggregated on the basis of estuarine marsh habitat and nursery grounds. A significant portion of that catch was landed in Mississippi, Alabama, and Florida.

c/ Millions of pounds.

d/ Millions of 1983 dollars. Value for all species except oysters represents running average of 1974-1978 exvessel prices brought to 1983 price levels using the Consumer Price Index for food. Average price for oysters calculated for period 1976-1980.

e/ Reflects 200 percent increase of reported inshore landings, based on surveys conducted by Louisiana Department of Wildlife and Fisheries (C.J. White, personal communication, letter dated April 23, 1979).

f/ Reflects 150 percent increase of reported landings, based on Mackin and Hopkins (1962) and Lindall et al. (1972).

g/ Includes food fish and industrial bottomfish. Quantities of croaker, spot, and seatrout calculated after Lindall et al. (1972).

Table 4. Commercial harvest of catfish and bullheads from Hydrologic Units II and IV of coastal Louisiana, including landings by other states (1963-76)

Year	Hydrologic Units II	Hydrologic Units IV
	Thousands of pounds	
1963	---	2,479.5
1964	---	2,932.1
1965	---	1,700.6
1966	---	1,485.1
1967	---	1,111.1
1968	---	1,132.1
1969	---	1,334.3
1970	---	1,028.6
1971	---	668.9
1972	---	920.3
1973	---	788.4
1974	21.7	676.6
1975	---	653.8
1976	---	970.5
14 Year Total	21.7	17,881.9
14 Year Average	1.5	1,227.3

Fishery Resources

Freshwater

Freshwater finfishing occurs in the fresh to slightly brackish waters in the upper portions of the two hydrologic units of the study area. Species commonly taken include largemouth bass, black crappie, white crappie, warmouth, bluegill, redear sunfish, channel catfish, blue catfish, and flathead catfish. Red swamp crawfish are also taken in the wooded swamps and fresh marshes. The primary freshwater commercial species harvested in the study area include red swamp crawfish, gars, bowfin, carp, freshwater drum, buffalofishes, blue catfish, channel catfish, flathead catfish, and yellow bullhead. Commercial harvest data (1963-1976) for freshwater species by hydrologic unit are available only for catfish and bullheads (Table 4). As noted in Table 4, reported landings of catfish and bullheads in Unit II have been negligible, except for 1974 when about 21,700 pounds were recorded. Reported landings in Unit IV peaked in 1964, and have not exceeded 1,000,000 pounds since 1970. The bulk of the catfish harvest in Unit IV is derived from Lake Salvador and Lac Des Allemands.

Estuarine/Marine

Saltwater fishing in the study area is extensive. Commonly pursued finfishes include spotted seatrout, sand seatrout, red drum, black drum, Atlantic croaker, southern kingfish, and southern flounder. Sport crabbing and sport shrimping are also popular activities in the study area. Table 5 provides a summary of the 1963-1978 average annual commercial harvest and value of the major estuarine-dependent commercial fishes and shellfishes by hydrologic unit in the study area. As noted in Table 5, menhaden dominated the total poundage harvested, while shrimp ranked first in total value. Other commercially important species include blue crab, American oyster, Atlantic croaker, spotted seatrout, sand seatrout, spot, and red drum. Hydrologic Unit IV far exceeds Hydrologic Unit II in total value and weight of landings. A wealth of information on the biology and harvest of the commercially important estuarine fishes and shellfishes of coastal Louisiana has been compiled in a report prepared by the National Marine Fisheries Service (Lindall et al. 1972).

Wildlife Resources

Because of the diversity and areal extent of productive habitat types in the study area, the area supports a wide variety of wildlife. These include game species, commercially important furbearers, endangered species, and other nongame species.

Game Species

Common migratory puddle ducks in the study area include mallard, green winged teal, blue-winged teal, pintail, American widgeon, gadwall, and northern shoveler. These ducks reach highest concentrations in the fresh and intermediate marshes of the study

Table 10. Comparison of future without-project (FWOP) and future with-project (FWP) acreages of fresh-intermediate, brackish, and saline marsh in Hydrologic Unit II (Breton Sound Basin), Louisiana Coastal Area

	Marsh Type (Acres)			
Target Year	Fresh-Intermediate	Brackish	Saline	Total
1978 (baseline)	13,595	131,257	46,766	191,618
1985 FWOP	11,072	130,538	41,329	182,939
FWP	11,072	130,538	41,329	182,939
1995 FWOP	8,258	128,318	34,641	171,217
FWP	76,889	105,042	0	181,931
2005 FWOP	6,159	125,052	29,035	160,246
FWP	73,425	99,306	0	172,731
2015 FWOP	4,593	121,051	24,335	149,979
FWP	70,115	93,883	0	163,998
2025 FWOP	3,426	116,546	20,397	140,369
FWP	66,955	88,756	0	155,711
2035 FWOP	2,555	111,724	17,096	131,375
FWP	63,938	83,909	0	147,847
Annualized FWOP	5,850	122,420	27,524	155,794
FWP	64,978	98,842	4,133	167,953
Net Change	+59,128	-23,578	-23,391	+12,159

Table [illegible]. Comparison of future without-project (FWOP) and future with-project (FWP) acreages of fresh-intermediate, brackish, and saline marsh in Hydrologic Unit IV (Barataria Basin), Louisiana Coastal Area

	Marsh Type (Acres)			
Target Year	Fresh-Intermediate	Brackish	Saline	Total
1978 (baseline)	196,647	111,661	157,489	465,797
1985 FWOP	164,002	114,422	152,059	430,483
FWP	164,002	114,422	152,059	430,483
1995 FWOP	124,538	113,465	144,625	384,628
FWP	138,454	116,065	146,648	401,167
2005 FWOP	97,632	108,471	137,554	343,657
FWP	121,464	113,671	141,600	376,735
2015 FWOP	75,330	100,891	130,829	307,050
FWP	111,078	108,691	136,898	356,667
2025 FWOP	58,122	91,788	124,433	274,343
FWP	105,786	102,188	132,525	340,499
2035 FWOP	44,845	81,926	118,349	245,120
FWP	104,424	94,924	128,462	327,810
Annualized FWOP	92,409	102,558	134,529	329,496
FWP	122,199	109,058	139,586	370,843
Net Change	+29,790	+6,500	+5,057	+41,347

It is estimated that the diversion of sediment-laden water into the predominantly open water overflow areas will produce a 4-square-mile delta and a 2-square-mile delta at the Davis Pond and Big Mar sites, respectively, during the life of the project. A considerable portion of these deltas should develop into fresh marsh and will aid in offsetting the present rapid loss of marsh in these areas. The temporary ponding of freshwater in the overflow areas is not expected to adversely impact the fresh marsh now existing in those areas.

Fisheries Impacts

The HEP have not been finalized for application to assessment of project impacts on fish and shellfish habitats. However, an analysis of the proposed project features on the monetary value of sport and commercial fishing was conducted; this analysis is contained in Appendix B. The marshes of the study area provide essential spawning, feeding and nursery habitat to the bulk of the commercially important fishes and shellfishes. In addition, these wetlands contribute decaying plant detritus, a vital component of the estuarine food chain, to adjacent waters. Therefore, the project-related reduction in marsh loss was used as the primary basis for estimating project benefits to fishery resources.

A summary of project-related changes in the magnitude and value of sport and commercial fishery resources is displayed in Tables 12 and 13. The following discussion is based on data shown in those tables.

Studies conducted by the NODCE Recreation Planning Section aggregated freshwater and saltwater sportfishing into a single sportfishing category. Personnel of that section have determined that, because the inadequate access to sportfishing areas is not projected to be alleviated over the period of analysis (1985 to 2035), sportfishing effort will remain at the present level throughout that period in both the FWOP and FWP conditions. However, the potential catch of sportfish, dependent to a large degree on the acreage of marsh, will decline at a slower rate under FWP conditions. Assuming that the value per man-day of sportfishing is at least partially dependent on potential catch per man-day, the average value per man-day will be higher under FWP conditions. As a result, the average annual value of sportfishing is projected to increase by nearly 8 percent in Unit II and nearly 13 percent in Unit IV under FWP conditions.

Because freshwater commercial fisheries account for less than one percent of the total commercial fishery harvest in the study area, quantitative estimates of project impacts on freshwater commercial fisheries were not developed. However, it should be noted that the increase in fresh-intermediate marsh and associated water acreage under FWP conditions in both basins should serve to increase freshwater commercial fish harvest. Saltwater intrusion is believed to be a major cause in the declining freshwater commercial fisheries catch in the study area in recent years.

The flushing of the open water outfall areas and increased flooding of perimeter wetlands is expected to increase populations of desirable sport and commercial species. Bryan and Sabins (1979) reported that

. ? .. Estimated sport and commercial fishing activities under future without-project (FWOP) and future with-project (FWP) conditions, Hydrologic Unit II (Breton Sound Basin), Louisiana Coastal Area

				(thousands)		
Activity	1985	FWOP 2035	FWP (2035)	FWOP Annualized (1985-2035)	FWP Annualized (1985-2035)	Net annualized increase-FWP (1985-2035)
Sportfishing a/						
man-days	136	136	136	136	136	0
value ($)	532	386	431	454	490	36
Commercial shrimp harvest b/						
pounds	12,469	8,955	10,049	10,619	11,428	809
gross value ($)	14,215	10,209	11,456	12,106	13,029	923
net value ($)	2,843	2,042	2,291	2,421	2,606	185
Commercial menhaden harvest b/						
pounds	11,218	8,056	9,041	9,553	10,282	729
gross value ($)	673	483	543	573	617	44
net value ($)	101	73	82	86	93	7
Commercial harvest-other finfish and crustaceans b/						
pounds	2,720	1,954	2,192	2,316	2,493	177
gross value ($)	953	684	767	811	873	62
net value ($)	143	103	115	122	131	9
Commercial oyster harvest c/						
pounds (meat)	5,977	4,292	12,520	5,090	12,193	7,103
gross value ($)	9,324	6,696	15,274	7,940	14,976	7,036
net value ($)	2,797	2,009	7,637	2,382	7,488	5,106

a/ From Table B-3, Appendix B.

b/ From Table B-4, Appendix B.

c/ From Table B-5, Appendix B.

Table 13. Estimated sport and commercial fishing activities under future without-project (FWOP) and future with-project (FWP) conditions, Hydrologic Unit IV (Barataria Basin), Louisiana Coastal Area

	(thousands)					
Activity	1985	FWOP (2035)	FWP (2035)	FWOP Annualized (1985-2035)	FWP Annualized (1985-2035)	Net annualized increase-FWP (1985-2035)
Sportfishing a/						
man-days	514	514	514	514	514	0
value ($)	1,939	1,116	1,476	1,491	1,679	188
Commercial shrimp harvest b/						
pounds	39,058	22,240	29,742	29,895	33,646	3,751
gross value ($)	44,526	25,354	33,906	34,080	38,357	4,277
net value ($)	8,905	5,071	6,781	6,816	7,671	855
Commercial menhaden harvest b/						
pounds	208,690	118,829	158,916	159,733	179,777	20,044
gross value ($)	12,523	7,131	9,536	9,585	10,788	1,203
net value ($)	1,879	1,070	1,430	1,438	1,618	181
Commercial harvest-other finfish and crustaceans b/						
pounds	22,872	13,023	17,417	17,506	19,703	2,197
gross value ($)	6,360	3,621	4,843	4,868	5,479	611
net value ($)	954	543	726	730	822	92
Commercial oyster harvest c/						
pounds (meat)	9,363	5,331	20,260	7,138	19,715	12,577
gross value ($)	14,606	8,316	24,717	11,136	24,212	13,076
net value ($)	4,382	2,495	12,359	3,341	12,106	6,538

a/ From Table B-3, Appendix B.

b/ From Table B-4, Appendix B.

c/ From Table B-5, Appendix B.

the standing crop of fishes in the lower Atchafalaya Basin of south-central Louisiana, where extensive riverine flooding of adjacent swamps occurred, was 55 percent higher than that recorded for the upper Atchafalaya Basin which lacked riverine influence and associated annual flooding of perimeter wetlands. Especially notable was that the standing crop estimates for largemouth bass in the area under riverine influence were five to eight times higher than those for areas not receiving riverine influence. In addition, estimated catfish populations were up to ten times greater in areas receiving riverine influence. Bryan and Sabins (1979) also reported that eutrophication in upper Atchafalaya Basin lakes lacking riverine influence favored primary consumers such as gizzard shad and carp, which are undesirable from a sport and commercial standpoint. These researchers advocated flushing of the river swamp areas with "aerated" mainstream waters to improve aquatic productivity. Accordingly, it is believed that seasonal flooding and flushing of the wetlands that border the freshwater diversion outfall sites will improve overall aquatic productivity and provide increased spawning and nursery areas for sport and commercial species.

It is also likely that flushing of the wetlands bordering the outfall areas will increase production of red swamp crawfish. Commercial harvest of crawfish in these wetlands is presently low, due in part to inadequate flushing of the swamp and associated depressed dissolved oxygen levels in swamp waters. The increased waterflow through the adjacent swamp would tend to increase dissolved oxygen levels as well as the extent of flooded wetlands, favoring crawfish production.

Because of reductions in the rate of marsh loss and the creation of more favorable salinity gradients, the project is expected to substantially benefit estuarine-dependent commercial fishery resources. Details regarding the analysis of project impacts on estuarine-dependent commercial fisheries are contained in Appendix B. As a result of freshwater introduction into Breton Sound Basin, the average annual commercial harvest of shrimp, menhaden, and other finfish and crustaceans (i.e., Atlantic croaker, spot, red drum, seatrouts, and blue crab) is expected to increase by 1.7 million pounds and the average annual commercial oyster harvest is expected to increase by 7.1 million pounds (Table 12). The annualized net value of this increased harvest is over $5.3 million.

Freshwater introduction into the Barataria Basin is expected to produce a net annualized increase of almost 26 million pounds in the commercial harvest of shrimp, menhaden, and other finfish and crustaceans, and lead to an increase of 12.6 million pounds in the commercial oyster harvest (Table 13). The annualized net value of this increased harvest of shrimp, oysters, menhaden and other finfish and crustaceans is over $7.6 million.

A substantial fishery for gizzard shad (important as crab and crawfish bait) and possibly other species such as blue catfish is expected to develop at the proposed discharge sites. Commercial fishermen presently take large quantities of gizzard shad from the tailwaters of the Bayou Lamoque Diversion Structure located along the Mississippi River near Mile 33.1 AHP. Blue catfish are also reportedly taken in large numbers immediately downstream from this structure. Based on

these observations, we believe that similar fisheries will develop at those structures proposed for installation along the Mississippi River, providing additional but presently unquantified economic returns.

Wildlife Impacts

A summary of the anticipated FWP and FWOP changes in marsh wildlife populations and sport hunting use is contained in Table 14. It is apparent from those data that wildlife populations and the number of days of sport hunting that those populations can support will decline considerably in the FWOP condition in both basins. Improved habitat quality and reduced rates of habitat loss in the Breton Sound Basin under the FWP condition, will actually increase wildlife population sizes and days of hunting opportunity above that experienced under existing (i.e., 1985) conditions. Under the FWP condition, wildlife populations and hunting opportunities in the Barataria Basin will be lower than under existing conditions, but will be significantly higher than that experienced in the FWOP conditions.

The number of commercially important fur animals and alligators under FWP and FWOP conditions was not determined. However, calculations by the NODCE Economic Branch indicate that the proposed freshwater diversion into Unit II (Breton Sound Basin) will result in an average annual increase in the net value of fur animal and alligator harvests of $138,000 and $96,000, respectively (Table B-12 in Appendix B). For Unit IV (Barataria Basin), these average annual increases for fur animal and alligator harvests are valued at $90,000 and $85,000, respectively.

The results of the habitat-based analysis (Appendix A) is summarized in Table 15. Average Annual Habitat Units (AAHUs) are the basic units of measure in describing changes in habitat quality and quantity associated with a proposed action. For Unit II, large gains in AAHUs are expected for alligator, puddle ducks and nutria (29,838; 39,888; and 35,442 AAHUs, respectively). A large area of brackish marsh, the type of marsh that supports peak muskrat populations, will be converted to fresh-intermediate marsh under FWP conditions. Therefore, muskrats will experience a decline of 18,906 AAHUs in Unit II under FWP conditions. Under FWP conditions, gains in AAHUs will be experienced in Unit IV for all of the species evaluated. These gains include 25,426 AAHUs for alligators; 10,861 AAHUs for muskrats; 20,566 AAHUs for nutria; and 21,072 AAHUs for puddle ducks.

A biological assessment of the impacts of freshwater introduction at the Big Mar and Bayou Lasseigne (i.e., the site being evaluated prior to the Davis Pond site) sites on the endangered bald eagle, brown pelican and Artic peregrine falcon was transmitted by the NODCE Planning Division Chief to the FWS Area Manager in Jackson, Mississippi, by letter dated July 4, 1981. Following a review of that assessment and additional data, the Acting FWS Area Manager, by letter dated July 28, 1981, informed the NODCE Planning Division Chief of his concurrence that freshwater introduction at those sites would have no significant effect on the aforementioned species. By letter dated January 28, 1983, the NODCE Planning Chief informed the FWS that the

Projected wildlife populations and sport hunting use under future without-project (FWOP) and future with-project (FWP) conditions in Hydrologic Units II and IV, Louisiana Coastal Area a/

ecies	Number of animals 1985	FWOP (2035)	FWP (2035)	Hunting use (man-days) 1985	FWOP (2035)	FWP (2035)
it II reton Sound)						
Deer	33	8	192	321	74	1,854
Rabbit	64,884	47,678	65,533	20,280 b/	15,619 b/	21,478 b/
Mottled ducks c/	803	597	1,187	d	d	d
Waterfowl other	e	e	e	56,143	44,345	63,339
Other marsh birds	e	e	e	36,956	25,758	27,795
it IV arataria Basin)						
Deer	492	135	313	4,756	1,301	3,028
Rabbit	142,976	67,028	103,028	46,903 b/	21,993 b/	33,800 b/
Mottled ducks c/	2,601	995	1,780	d	d	d
Waterfowl other	e	e	e	126,594	55,392	89,627
Other marsh birds	e	e	e	90,358	53,420	69,594

From Tables B-8 and B-9, Appendix B.

Represents total small game hunting effort, of which rabbit is primary species.

Represents estimated number of breeding pairs.

Mottled duck hunting use is included with waterfowl (other) hunting.

Population data unavailable.

Table 15. Comparison of Average Annual Habitat Units (AAHU) under future without-project (FWOP) and future with-project (FWP) conditions in marshes influenced by freshwater diversions via Big Mar (Hydrologic Unit II) and Davis Pond (Hydrologic Unit IV) diversion sites

	Unit II			Unit IV		
Evaluation Elements	AAHU-FWP	AAHU-FWOP	Change in AAHU	AAHU-FWP	AAHU-FWOP	Change in AAHU
Alligator	104,603	74,765	+29,838	152,454	127,028	+25,426
Muskrat	89,551	100,457	-18,906	150,071	139,210	+10,861
Puddle Ducks	73,170	33,282	+39,888	115,108	94,036	+21,072
Nutria	55,767	20,325	+35,442	97,443	76,886	+20,556

Barataria Basin freshwater diversion site was being relocated from Bayou Lassaigne to Davis Pond. That letter included an amended biological assessment (Biological Assessment Amendment #1) discussing the impacts of that site change. In a March 2, 1983, letter to the NODCE Planning Division Chief, addressing that amended biological assessment, the FWS requested that the assessment be revised to include a discussion of the impact of freshwater introduction on bald eagle nesting habitat in the Barataria Basin. Following further review of the January 1983 amended biological assessment, the FWS concluded in a March 28, 1983, letter to the District Engineer, NODCE, that freshwater diversion at the new site may affect the endangered bald eagle. The FWS also recommended in that letter that formal consultation be initiated and requested additional information needed for the FWS to render a formal Biological Opinion.

Via letter dated July 5, 1984, the NODCE Planning Chief transmitted to FWS another amended biological assessment (Biological Assessment Amendment #2) containing the additional information requested in the FWS March 28, 1983, letter. In a July 24, 1984, letter to NODCE, FWS requested that the Corps of Engineers incorporate into project plans a commitment to compensate for possible future adverse impacts to the bald eagle due to project implementation. Actions to be included under that commitment would include:

(1) temporary closure of the Davis Pond diversion structure to allow identified pollutants to pass before re-initiation of diversion;

(2) supplemental feeding to provide adult eagles a clean food source;

(3) capture of adult eagles, and captive propagation of their young at a facility such as the Patuxent Wildlife Research Center, and fostering (or hacking) of the young back into appropriate habitat in southern Louisiana; and

(4) fostering or hacking of young bald eagles in southern Louisiana from sources other than the pair(s) which nested in the project area.

In an August 28, 1984, letter to the FWS, NODCE committed to action (1) in the event of any significant contaminant spill on the Mississippi River. Further, NODCE agreed that if future monitoring indicates that unacceptable levels of contaminants, as a result of project operation, are adversely affecting eagle nesting success, actions (3) and (4) would be conducted for a maximum of 10 years. As agreed during an August 13, 1984, conversation between FWS and NODCE, action (2) would be eliminated from further consideration.

Via a September 12, 1984, letter to the NODCE, FWS provided a Biological Opinion regarding the anticipated effects of the tentatively selected plan on the bald eagle which completed formal consultation under Section 7 of the Endangered Species Act. The opinion, that the proposed project... "is not likely to jeopardize the continued existence of the bald eagle or result in the destruction or

adverse modification of critical habitat," was based upon the following considerations:

(1) In the future without-project condition, bald eagle nesting habitat in the project area near the Davis Pond diversion would likely be severely impacted as a result of saltwater intrusion.

(2) The future with-project condition would reduce saltwater intrusion and offer an opportunity to preserve bald eagle nesting habitat.

(3) NODCE has committed itself to a tissue sampling program within the receiving (outfall) area (reference Biological Assessment Amendment #2)

(4) NODCE has committed to compensate for future losses in bald eagle reproductive success within the project area due to the bioaccumulation of toxic materials.

In that letter, FWS also made the following two additional recommendations:

(1) All construction work conducted within one mile of the bald eagle nest at Lake Cataouatche should be accomplished during the non-nesting period (i.e., May 15 - October 1 of any year).

(2) The tissue sampling effort, cited above, should be conducted during the three years prior to initiating freshwater diversion and during the four years following initiation of freshwater diversion. Those seven years of data would be used to determine the frequency of future tissue sampling throughout the remainder of the life of the project.

Water Quality Impacts

A detailed discussion of existing water quality in the Mississippi River and adjacent freshwater and estuarine water bodies, as well as potential impacts of the proposed action on water quality in the study area, is contained in the EIS and Appendix H accompanying the FR prepared by NODCE. The following is a more specific discussion of some of those water quality issues of greatest potential concern with respect to fish and wildlife resources and associated human uses.

A major concern is the possible increase in pollutants introduced into the study area water bodies via diverted Mississippi River water. Those types of pollutants of greatest concern are insecticides and herbicides, polychlorinated biphenyls (PCB's), heavy metals, and substances such as phenolic compounds that cause "off" flavors in fishes consumed by humans.

Pesticides tested for in the lower Mississippi River include organochlorine and organophosphorous insecticides and chlorophenoxy

herbicides. According to data presented by Wells (1980), DDT, dieldrin and endrin are the most frequently occurring organochlorine insecticides in the lower Mississippi River below St. Francisville, Louisiana. Wells reported that DDT and dieldrin were detected in about 25 percent of the samples taken in that segment of the river during 1973-1977, with concentrations rarely exceeding 2 parts per billion (ppb) for DDT and 0.1 ppb for dieldrin. Endrin was detected in approximately 10 percent of the samples and did not exceed 0.01 ppb in the samples taken. When these pesticides were detected, however, their concentrations were usually above maximum levels recommended by the Environmental Protection Agency (EPA) for protection of aquatic life (i.e., DDT, 0.001 ppb; dieldrin, 0.0019 ppb; and endrin, 0.0023 ppb). Diazinon is the most common organophosphorous insecticide in the lower Mississippi River, having been detected in 40 percent of the samples taken below St. Francisville during 1973-1977 (Wells 1980). Concentrations did not exceed 0.05 ppb 95 percent of the time.

The most common chlorophenoxy herbicide is 2,4-D, which Wells (1980) reported as occurring in 70 percent of the samples taken in the lower Mississippi River. Concentrations of this compound were relatively low, i.e., less than 0.08 ppb 90 percent of the time. The herbicides Silvex and 2,4,5-T were detected in 20 and 60 percent, respectively, of the samples taken. Silvex concentrations have not exceeded 0.01 ppb, while concentrations of 2,4,5-T were usually equal to or less than 0.04 ppb 95 percent of the time.

Probably the most serious concern over diversion of Mississippi River water into adjacent water bodies is the potential for rendering fishes and shellfishes in those waters unsafe for human consumption because of a buildup of pesticides, heavy metals, and "off" flavors in these organisms. One method of addressing this problem is to examine data on pesticide, heavy metals, and off-flavors in aquatic organisms taken from the Mississippi River and water bodies receiving Mississippi River influence. Table 16 summarizes data obtained from an analysis of 30 fish samples (consisting of about 130 individual fish) taken from the lower Mississippi River at Luling, Louisiana. As noted in that table, average tissue concentrations of the pollutants listed did not exceed recommended maximum safe concentrations (action levels) established by the Food and Drug Administration (FDA). Maximum concentrations of PCB's recorded for one channel catfish and one freshwater drum exceeded the FDA action level of 5 ppm. Only one specimen, a striped mullet, exceeded the FDA action level for dieldrin (0.3 ppm); this specimen contained a dieldrin concentration of 0.390 ppm. The only other action level that was exceeded by any of the fishes sampled included a carp whose tissue sample yielded a maximum heptachlor epoxide concentration of 0.4 ppm; the FDA action level for heptachlor epoxide is 0.3 ppm. In summary, a surprisingly small number of the fishes analyzed contained concentrations of pollutants which exceeded the FDA action levels for these substances.

As a result of concerns expressed by commercial catfishermen over the potential for polluting commercial catfish stocks, the FWS again evaluated catfish tissue data collected from the Mississippi River as well as the Davis Pond outfall area. On September 1, 1982, five channel catfish were collected from each of two sites in the

Table [illegible]. Summary of concentrations of select pollutants in fishes taken from the Mississippi River at [illegible], Louisiana, during 1969-1979 by U.S. Fish and Wildlife Service (concentrations in parts per million) a b

[illegible]	Total DDT	Toxaphene	Total PCB's	Dieldrin	Endrin	Heptachlor epoxide	C-Chlordane	T-Chlordane	C-Nonachlor	T-Nonachlor	Lindane	Lead	Mercury
Freshwater drum [illegible]	[illegible] [illegible]	[illegible] [illegible]	[illegible] [illegible]	[illegible] [illegible]	0.079 (0.180)	0.040 (0.060)	0.090 (0.120)	0.067 (0.090)	0.023 (0.030)	0.090 (0.110)	0.017 (0.020)	0.153 (0.170)	0.083 (0.120)
Carp [illegible]	[illegible] [illegible]	[illegible] (2.5[illegible])	[illegible] [illegible]	[illegible] [illegible]	[illegible] [illegible]	0.055 ([illegible])	0.060 (0.070)	0.065 (0.070)	0.010 (0.010)	0.000 (0.000)	0.000 (0.000)	c c	c c
Largemouth bass (1)	[illegible]	[illegible]	[illegible].600	[illegible].030	[illegible]	0.010	0.040	0.010	0.020	0.040	0.000	c	c
Channel catfish (5)	[illegible] [illegible]	[illegible] [illegible]	2.370 (6.600)	0.124 (0.260)	0.138 (0.200)	0.006 ([illegible])	c c	c c	c c	c c	c c	c c	c c
Blue catfish (3)	[illegible] ([illegible])	1.533 (4.600)	[illegible] ([illegible])	0.113 (0.230)	0.000 (0.000)	0.000 (0.000)	c c	c c	c c	c c	c c	c c	c c
Smallmouth buffalo (2)	[illegible] [illegible]	3.200 ([illegible])	0.850 (1.400)	0.000 (0.000)	0.000 (0.000)	c c	c c	c c	c c	c c	c c	c c	c c
Bigmouth buffalo (2)	[illegible] ([illegible])	0.000 (0.000)	1.510 ([illegible])	0.285 (0.290)	0.200 (0.210)	0.000 (0.000)	c c	c c	c c	c c	c c	c c	c c
Striped mullet (1)	[illegible]	c	1.390	0.390	c	0.000	c	c	c	c	c	c	c

a Upper number represents mean concentration; lower number is maximum concentration. Underlined values exceed "action levels" set by Food and Drug Administration (see footnote b).

b Food and Drug Administration "action levels" (recommended maximum safe concentrations for human consumption) are: 5 parts per million (ppm) for PCB's, DDT, and Toxaphene; 0.3 ppm for Heptachlor Epoxide, Dieldrin, Endrin, Chlordane, and Lindane; and 1 ppm for Mercury. Action level not established for lead.

c Analysis not performed for pollutant indicated.

ssissippi River near Waggaman (near the site of diversion of river
ter) and from a site on the northern end and a site on the southern
d of Lake Cataouatche. The five fish at each site were composited
d the edible portions analyzed for heavy metals, chlorinated
secticides, PCB's, and chlorophenols. The levels detected were
mpared to FDA action levels. Although FDA has developed an action
vel in fish for only one of the analyzed metals (i.e., mercury), all
her metals tested (including arsenic, lead, nickel, copper, zinc,
omium, and cadmium) with the exception of zinc were reported at or
ar the analytical detection limit. Although the FDA action level
r mercury has been established at 1.0 ppm, none of the mercury
lues for any of the samples exceeded 0.05 ppm. It is interesting to
te that zinc concentrations were highest in fish taken from Lake
taouatche and lowest in fish taken from the Mississippi River. With
e exception of minor levels of DDE, a breakdown component of DDT,
ne of the other tested chlorinated hydrocarbons or PCB's were
tected in samples from Lake Cataouatche. Although detectable levels
a number of these compounds were found in samples from the
ssissippi River, none approached FDA action levels. Although these
ta are somewhat limited, the following summary observations could be
de: (1) there was no significant difference between metal levels in
sh collected in the Mississippi River versus fish collected in Lake
taouatche; (2) all reported metal levels were low, being below or
ar the analytical detection limit; (3) and although several
lorinated hydrocarbon pesticides were detected in low concentrations
ll below the FDA action level) from fish in the Mississippi River,
ey were not present in detectable concentrations in catfish from
ke Cataouatche.

e development of "off" flavors in fishes taken from the Mississippi
ver was a serious prob'em in the early 1970's. Although there are a
de variety of compounds that have been associated with the tainting
fish flesh, phenolic compounds are generally considered the primary
bstances which cause this tainting. Tests conducted by the U.S.
vironmental Protection Agency in 1972 indicated that catfish in the
ssissippi River below Baton Rouge, Louisiana, possessed moderate to
ry strong off-flavors. However, an apparent decline in this problem
revealed by records of commercial landings of catfish and
llheads, compiled by the National Marine Fisheries Service, for the
ssissippi River below the Bonnet Carre Spillway. As shown in Table
, those records reveal that catfish and bullhead landings declined
om 202,000 pounds in 1964 to 46,000 pounds in 1968, and then
amatically rose to nearly 1.4 million pounds by 1977. The last year
r which landing records are available is 1978; landings declined to
3,000 pounds during that year but were more than 6 times the average
ndings for the period 1965 through 1969. It is quite possible that
ese increases in landings are a result of reduced concentrations of
enolic compounds in the lower Mississippi River, caused by more
ringent control of industrial discharges of these and other
llutants. In the previously referenced September 1982 analysis of
annel catfish tissue by the FWS, phenol levels were tested to
aluate fish flesh tainting. Although the limited sample size did
t provide conclusive results, the tests did indicate that all
alyzed phenols, with the exception of pentachlorophenol (which is

i. Comparison of future without-project (FWOP) and future with-project (FWP) acreages of fresh-intermediate, brackish, and saline marsh in Hydrologic Unit II (Breton Sound Basin), Louisiana Coastal Area

	Marsh Type			
ear	Fresh-Intermediate	Brackish	Saline	Total
seline)	13,595	131,257	46,766	191,618
P	11,072	130,538	41,329	182,939
	11,072	130,538	41,329	182,939
P	8,258	128,318	34,641	171,217
	76,889	105,042	0	181,931
P	6,159	125,052	29,035	160,246
	73,425	99,306	0	172,731
P	4,593	121,051	24,335	149,979
	70,115	93,883	0	163,998
P	3,426	116,546	20,397	140,369
	66,955	88,756	0	155,711
P	2,555	111,724	17,096	131,375
	63,938	83,909	0	147,847
ed FWOP	5,850	122,420	27,524	155,794
FWP	64,978	98,842	4,133	167,953
Change	+59,128	-23,578	-23,391	+12,159

Since early 1970's, the Fish and Wildlife Service (FWS) has promoted the use of habitat-based evaluations of impacts of water resource development projects. The development of the Habitat Evaluation Procedures (HEP) is a result of that commitment. It is the policy of the FWS to use HEP when applicable. If this is not possible, the use of a habitat based evaluation method which embodies the principal concepts and assumptions of HEP is encouraged. The basic assumptions of HEP are that all habitat has value to wildlife and that impacts to wildlife habitat, in terms of changes in the quantity and/or quality, can be measured and compared. These changes are measured in terms of Habitat Units (HUs) which are a product of a measure of the habitat available (acres) and an index to the quality of the habitat available. This quality index, the Habitat Suitability Index (HSI), is assumed to be directly proportional to the carrying capacity of the habitat for the evaluation species of interest. The current HEP procedures encourage the use of models to determine the HSI for a given evaluation species.

When this analysis was initiated, HSI models for species which are representative of the coastal area of Louisiana were not available. However, several publications which reported the carrying capacities of several marsh habitat types for such species were available. Therefore, during this analysis the HSI was calculated by using a ratio of highest reported populations to those experienced in the sample areas. Detailed explanations of HSI determinations for each evaluation species are presented later in this appendix.

The analysis for this project was performed during the period September 1980 through February 1982. Most of the required field sampling was conducted during the period February 4 to April 8, 1981. The FWS maintained lead role in the analysis, with assistance from biologists of the Louisiana Department of Wildlife and Fisheries and the New Orleans District, Corps of Engineers (NODCE). Since the direct adverse impacts, on fish and wildlife resources, of construction and maintenance activities associated with the diversion structures are viewed as minor compared with the anticipated beneficial impacts on the wetlands of the hydrologic units receiving the diverted waters, the habitat-based analysis was conducted only on the fresh-intermediate, brackish and saline marshes to be affected by the proposed supplemental introduction of fresh water.

The most significant impact of freshwater introduction is expected to be a reduction in the rate of land loss and saltwater intrusion that would have occurred without the introduction of freshwater. As discussed in the main report, this reduction in wetland deterioration is based on increased nutrient input, reduced saltwater intrusion, and increased sediment input. Tables A-1 and A-2 provide a comparison of FWOP and FWP marsh acres in Hydrologic Units II and IV, respectively. As noted in these tables, the quantity of total marsh will be relatively greater in both of these units under FWP conditions. Acreages are expected to be larger in each marsh type (i.e., fresh-intermediate, brackish, and saline marsh) in Hydrologic Unit IV

LOUISIANA

COASTAL AREA STUDY

APPENDIX A

HABITAT-BASED

ANALYSIS

OF

TENTATIVELY SELECTED

PLAN

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4. The final feasibility report request (a) authority to secure sufficient land easement and/or title to allow for future enlargement of the proposed structures and (b) authority for enlargement of the proposed structures if, in the opinion of the District Engineer, such action would be justified to maximize project benefits; and

5. The final feasibility report recommend authorization for provision of bank fishing facilities along outflow channels near the proposed diversion structures, and public boat launching ramps at locations in the study area identified during post-authorization studies.

Studies by the NODCE Recreation Planning Section also disclosed a significant shortage of public boat launching ramps in the study area. The referenced post-authorization studies should also include feasibility analyses of installing additional public boat launching facilities at partial Federal expense, as the benefits to be realized by such new facilities would probably far outweigh the costs.

Additional Considerations

One of the four freshwater diversion structures authorized under the "Mississippi Delta Region, Louisiana" project is located on the right bank of the Mississippi River near Myrtle Grove. In the past, there has been little public support for proceeding with construction of that structure. However, elected officials from the affected area have, in recent years, expressed support for a freshwater diversion structure at that site. This site was one of the four sites recommended by FWS in 1959. The construction of both the Myrtle Grove and Davis Pond diversion structures would allow for greater operational flexibility and would enhance dispersal of fresh water in the eastern portion of Barataria Bay. However, should only one structure be deemed justifiable, the FWS would prefer that the Davis Pond Site be constructed. The latter site would allow greater solar heating of the colder river water before reaching the prime shrimp nursery grounds, would flow through a larger acreage of marsh (thereby facilitating removal of pollutants), and would be more effective in reducing saltwater intrusion and land loss in the fresh/ intermediate marsh zone.

RECOMMENDATIONS

Based on a review of the tentatively selected plan for providing supplemental fresh water into the Breton Sound and Barataria basins, the FWS recommends that the following measures be implemented in the interest of fish and wildlife conservation:

1. The tentatively selected plan be recommended for authorization in the final feasibility report;

2. The first costs of the proposed project features be borne totally by the Federal government;

3. The final feasibility report request authority for funding of post-authorization studies to include participation of the FWS, LDWF, and the National Marine Fisheries Service in the detailed design of the proposed structures, the development of operational and maintenance guidelines, the design of pre- and post-construction monitoring studies of the areas to be affected, and the formulation of water management plans for the affected areas;

responsibility; operation and maintenance under the mitigation scenario is considered to be a Federal responsibility. Specific operational guidelines would be developed during the design stages, and should include broad input from Federal, State and local agencies having expertise in such fields as fish and wildlife management, flood control, and public health.

Monitoring

In concert with development of operational guidelines, a monitoring program should be developed to gauge the effectiveness of the proposed measures. Monitoring should include such items as water quality (e.g., salinity, nutrient levels, water temperature, turbidity, etc.), vegetation patterns, wildlife population enumeration (alligator nest counts, muskrat house counts, waterfowl censusing, etc.), and contaminant levels in selected fish and wildlife species. Extensive sampling programs are already carried out by state and local agencies such as the LDWF, Louisiana Department of Health and Human Resources, the Plaquemines Parish Mosquito Control District, and various parish planning agencies. Therefore, overall coordination of these programs may achieve many of the monitoring objectives. Post-construction monitoring may reveal the need for some enlargement of the control structures in order to achieve the desired salinity regimes in the affected basins. This is understandable, given the nature of the data utilized to predict supplemental flow requirements. Therefore, provisions should be made for enlargement of the proposed structures when such need is indicated by post-construction monitoring.

Intrabasin Water Management

In order to maximize benefits to be obtained from the supplemental freshwater introduction, it will be necessary to develop and implement a water management scheme for each of the affected hydrologic units (drainage basins). Such plans would probably include low crest wiers, earthen plugs in existing canals, minor ditching to connect certain waterways, and other measures to maximize distribution of the diverted water. Detailed water management plans for Hydrologic Unit II have already been developed by Plaquemines Parish. In addition, it has been suggested that Louisiana's Coastal Environment Protection Trust Fund be used as a source of funding for design of water management plans for the affected basins. Nevertheless, provision of funding for Federal participation in post authorization water management studies should be recommended in the FR.

Recreational Development

It is anticipated that large numbers of harvestable-size finfishes will congregate in the outflow channels near the proposed diversion structures. Providing adequate fisherman access to these sites would allow for a significant amount of bank fishing, a potential recreational benefit that was not quantified in this report or in the FR. Therefore, the feasibility of including bank fishing facilities at the proposed diversion structures and associated outflow channels should be addressed in post-authorization studies.

commercial fishery landings. Applicable laws and regulations dealing with cost sharing for Federal water development projects provide for the Federal government to assume 100 percent of the first costs of commercial fishery enhancement projects, provided that all costs for operation, maintenance and replacement are assumed by non-Federal interests or a Federal fisheries agency. Clearly, the tentatively recommended plan, by virtue of its preponderance of commercial fisheries benefits, meets the requirements for 100 percent Federal funding for project costs.

Another cost sharing alternative is to classify the tentatively selected plan as a mitigation measure, in view of the dominant role played by the Mississippi River levees in the acceleration of wetland deterioration in southeastern Louisiana. These levees have halted the historic overflow of sediments and fresh water to adjacent subdelta marshes, leading to accelerated subsidence, erosion and saltwater intrusion. Present cost sharing requirements for mitigation of fish and wildlife losses associated with Federal water development projects are the same as for the purpose causing the damages. The Mississippi River levees, constructed under the MR&T authority for the purpose of flood control, are a totally Federal responsibility; therefore, 100 percent of the costs for mitigation of the fish and wildlife losses caused by this project would also be borne by the Federal government under this scenario.

NODCE representatives have advised that they have been directed by higher authority to seek "innovative approaches" for funding of this and other Federal water development projects. This has led to the recommended 75 percent Federal - 25 percent local cost sharing formula, whereby the State of Louisiana would obtain its share of the needed funding from Louisiana's Coastal Environmental Protection Trust Fund authorized by Act 41 passed by the Louisiana Legislature in 1981. While this approach fails to recognize the need for mitigation of the effects of the mainline Mississippi River levees, it would prevent the placement of a large financial burden on local governing bodies (e.g., parish police juries). Cost sharing burdens on local governing bodies have apparently been a major factor in the failure to construct the four authorized diversion structures called for by the "Mississippi Delta Region, Louisiana" project.

Federally constructed Mississippi River levees have played, and will continue to play, a major role in the deterioration of productive subdelta marshes in the study area. In the absence of remedial measures, the most serious economic impact of this wetland loss over the period of analysis (1985-2035) for the present project will be a serious decline in the commercial fishery harvest of the study area. Therefore, it is the position of the FWS that the proposed freshwater introduction should receive 100 percent Federal funding. This could be provided under the commercial fisheries enhancement scenario or the mitigation scenario, both of which are described above.

Operation and Maintenance

Unless the mitigation cost sharing formula is selected, operation and maintenance of the proposed structures would be a non-Federal

DISCUSSION

Introduction

It is clear from the preceding section that the tentatively selected plan will have major beneficial impacts on fish, wildlife, and related resources. Of course, the concept of re-introducing fresh water from the Mississippi River into the adjacent wetlands of southeastern Louisiana is not a new one. A plan for introduction of Mississippi River water into the sub-delta marshes of southeast Louisiana was submitted by the FWS to the U.S. Army Corps of Engineers in 1959 (U.S. Fish and Wildlife Service 1959). This plan included a recommendation for the construction of four water control structures, having a combined discharge capacity of 24,000 cfs, to divert Mississippi River water for salinity control. Recognizing that this project was needed to partially rectify wetland degradation caused by the federally constructed Mississippi River mainline levees, the FWS (1959) recommended that the Mississippi River and Tributaries (MR&T) project authorized by the Flood Control Act of 1928 be amended to recognize fish and wildlife as a project purpose and to include the FWS freshwater introduction plan as an integral feature. That plan, now known as the "Mississippi Delta Region, Louisiana" project, was authorized by Public Law 89-298 on October 27, 1965. Detailed planning of one of the four authorized structures was started in 1969, but was suspended when local interests failed to provide economic justification for their requested change in the location of that structure. However, it should be noted that, despite the obvious need for the project to mitigate the adverse impacts of the Mississippi River levees, the project is classified as "enhancement", making local interests responsible for 25 percent of the project costs. For some time, this rather large financial burden was cited by local interests as one reason for their reluctance to participate in the project.

In recognition of the critical need to address marsh loss and saltwater intrusion, the State of Louisiana provided a letter of intent to the Corps of Engineers advising that agency of the State's intent to meet the requirements of local cooperation for the Caernarvon Freshwater Diversion Structure. The Caernarvon structure, which is virtually identical to the Big Mar site tentatively recommended under the present study authority, is one of the four freshwater diversion structures authorized by the Congress in 1965. It is our understanding that one of the recommendations emanating from the present study is that detailed design studies continue on the Caernarvon (Big Mar) site, pending appropriation of the necessary construction funds by the Congress. The FWS fully supports such action, as the need for freshwater diversion into the Breton Sound Basin is considered critical.

Cost Sharing

As evident from the PROJECT IMPACTS section, the great majority (i.e., nearly 95 percent) of the monetary benefits attributable to the tentatively selected plan would be associated with net increases in

reduced. In addition, continued marsh loss will dramatically reduce the productivity of the area. These factors would result in serious declines in catfish populations and catfish harvest in the FWOP condition.

Cooler and lower-salinity water could shift the existing soft-shell crab fishery south to the Lake Salvador/Little Lake area; however, this would not significantly affect overall crab populations. Brown shrimp and certain other estuarine-dependent species would shift further seaward as well. However, it must be emphasized that production of brown shrimp and other important commercially and recreationally exploited estuarine-dependent species is closely correlated with acreage of marsh. With implementation of the proposed project, significant marsh "savings" would accrue, thereby improving production of these species.

The Mississippi River receives municipal sewage discharge from numerous sources, located both upstream and within the study area. Fecal coliform bacteria reach high levels in Mississippi Rivers in the study area. Nevertheless, NODCE has predicted that, based on fecal coliform die-off rate calculations, fecal coliform bacteria would die off before reaching any oyster harvesting areas.

Non-quantifiable Impacts

In addition to those benefits quantified above, the reduction in the rate of wetland loss associated with the proposed freshwater introduction will have non-quantifiable beneficial impacts.

Marshes, in addition to providing habitat for fish and wildlife, perform a variety of functions. These wetlands act as a first line of defense against hurricanes by serving to buffer the adjacent mainlands against storm-driven waves. In addition marshes perform an important water quality function by removing excess nutrients from associated water bodies, thus helping to reduce water quality problems caused by eutrophication.

Louisiana's coastal marshes are of national importance to migratory waterfowl. Data compiled by the FWS reveal that 20 to 25 percent of all the migratory puddle ducks in North America winter in Louisiana's coastal wetlands. These marshes also provide temporary habitat to ducks and other waterfowl which winter in Central and South America. This reduction in the rate of loss of productive marshes, especially the fresher marsh types, should, therefore, substantially benefit an important international resource. Utilization of the living natural resources of Louisiana's coastal zone is an integral component of the culture of that area. Commercial and sport fishing, trapping, sport hunting and related activities in coastal Louisiana are largely dependent on the marshes. The reduction in the rate of loss of these wetlands will help to preserve the existence of these activities and thus an integral part of the culture of the Louisiana coastal marshes.

usually not associated with off-flavors), were below the level of detection.

Another source of concern is the possible buildup or "biological magnification" of pesticides, PCB's and other pollutants by brown pelicans, bald eagles, and other fish-eating birds. Indeed, a study by Cromartie et al. (1975) revealed widespread contamination of bald eagles with PCB's and DDE, a DDT derivative. These compounds have been shown to cause eggshell thinning in several fish-eating birds, a process blamed for reproductive declines in bald eagles and other species. However, it should be re-emphasized that as a result of recent Corps of Engineers commitments to take certain precautionary actions when necessary to protect fish and wildlife from contamination, the FWS has rendered a formal Biological Opinion that the proposed project is not likely to jeopardize the continued existence of the bald eagle.

Two other areas of potential water quality-related impacts have been the subject of considerable interest and concern. These include the impact of cooler Mississippi River water on estuarine organisms in the receiving water bodies and the impact of fecal coliform bacteria levels within the more inland oyster producing areas. The occurrence of the latter often suggests contamination by other human pathogenic bacteria and viruses. In order to address these issues, NODCE modeled the rate of warming of Mississippi River water as it traveled through the upper receiving areas and determined fecal coliform die-off rates for the Davis Pond and Big Mar sites.

It was calculated that incoming Mississippi River water would be warmed in the Davis Pond site outfall area by amounts ranging from 2.5°C in April up to 4.0°C in February, depending primarily on retention time in the overflow area. Additional warming of the river water during passage through Lake Cataouatche was calculated to be sufficient to establish equilibrium with normal existing temperatures in the upper Barataria Basin in the months of January, February, and May. During the months of March and April, water passing through Lake Cataouatche is predicted to be about 2.0°C cooler than the existing (ambient) water temperature. Initiating releases in a gradual fashion over several days at the beginning of a diversion season would allow most resident organisms sufficient opportunity to adjust to the somewhat cooler temperatures without significant adverse effects. It has been determined that flow through Big Mar and, subsequently, the relatively slow movement of water through numerous canals and bayous within the marsh would provide ample time for gradual warming of the water temperature to acceptable levels before reaching areas in Breton Sound Basin utilized by sensitive estuarine-dependent species.

Since the water temperature in Lake Cataouache would be slightly lowered during the months of diversion, catfish spawning would be slightly delayed and could be somewhat reduced during those months. However, considering all the impacts of introducing freshwater into the Barataria Basin, the long-term benefits to the catfish industry should far outweigh the adverse impacts. At the rate saltwater is intruding into the upper basin, the fresh and very low salinity areas suitable for existence of catfish populations will continually be

Table 17. Reported commercial harvest and value of catfishes and bullheads from Mississippi River Between Hahnville, Louisiana, and the Gulf of Mexico (1964-1978) a/

Year	lbs. (Thousands)	$
1964	202	46
1965	119	30
1966	72	20
1967	54	15
1968	46	13
1969	145	41
1970	180	52
1971	174	56
1972	131	39
1973	b	b
1974	772	231
1975	1,080	350
1976	1,163	386
1977	1,388	496
1978	573	217

a/ Data compiled from National Marine Fisheries Service landing records, all values in thousands.

b/ No data.

Table A-2. Comparison of future without-project (FWOP) and future with-project (FWP) acreages of fresh-intermediate, brackish, and saline marsh in Hydrologic Unit IV (Barataria Basin), Louisiana Coastal Area

	Marsh Type			
Target Year	Fresh-Intermediate	Brackish	Saline	Total
1978 (baseline)	196,647	111,661	157,489	465,797
1985 FWOP	164,002	114,422	152,059	430,483
FWP	164,002	114,422	152,059	430,483
1995 FWOP	124,538	113,465	144,625	384,628
FWP	138,454	116,065	146,648	401,167
2005 FWOP	97,632	108,471	137,554	343,657
FWP	121,464	113,671	141,600	376,735
2015 FWOP	75,330	100,891	130,829	307,050
FWP	111,078	108,691	136,898	356,667
2025 FWOP	58,122	91,788	124,433	274,343
FWP	105,786	102,188	132,525	340,499
2035 FWOP	44,845	81,926	118,349	245,120
FWP	104,424	94,924	128,462	327,810
Annualized FWOP	92,409	102,558	134,529	329,496
FWP	122,199	109,058	139,586	370,843
Net Change	+29,790	+6,500	+5,057	+41,347

under FWP conditions. However, because large volumes of fresh water will be discharged directly into brackish marsh in Unit II, there will be a large gain in the fresh-intermediate marsh and a reduction in the average annual acreage of the brackish and saline marsh types in that Unit.

In order to quantify the impact of these acreage changes on wildlife, HSI's were assigned to each of the three major marsh types for a list of evaluation elements common to all marsh types, i.e., American alligator, migratory puddle ducks, muskrat, and nutria. These species were selected because they are indicators of healthy, diverse wildlife habitat in Louisiana's coastal marshes. In addition, extensive research has been done on the relative abundance of each of these species in each of the marsh types being evaluated. Because of the extremely large size of the study area (over 613,000 acres of marsh), it was decided to use published information, in lieu of extensive field sampling, to assign HSI's.

The marsh type supporting the greatest abundance of an evaluation element (species) was assigned the highest HSI, and the remaining marsh types were assigned HSI's proportional to the abundance of an evaluation element in those marsh types compared to the abundance of the marsh type supporting the greatest abundance of that evaluation element.

The relative abundance data for nutria, muskrat, and migratory puddle ducks were taken from Palmisano (1973). For the American alligator, calculation of relative abundance was based on tag allotments noted in alligator harvest regulations adopted by the Louisiana Wildlife and Fisheries Commission (LWFC) in 1980. The manner in which these relative abundance values were used to calculate HSI's is discussed below for each evaluation element.

<u>Nutria</u> - It was assumed that the average catch of nutria by trappers per 1,000 acres of each marsh type represents an index of nutria abundance by marsh type. To convert these relative abundance values to HSI's, the marsh value with the highest nutria catch rate per 1,000 acres was assigned an HSI of 1.0, and the remaining marsh types assigned HSI's calculated by the following equation:

$$\text{Nutria HSI of particular marsh type} = \frac{\text{Mean nutria catch/1,000 acres of particular marsh type}}{\text{Mean nutria catch/1,000 acres of most productive marsh type}}$$

Table A-3 provides a display of mean nutria catch per 1,000 acres of each marsh type, the calculated HSI by marsh type, and the adjusted HSI by marsh types. All marsh types were assumed to be approximately 20 percent below maximum nutria productivity; therefore, HSI's for each marsh type were multiplied by 0.8 to obtain an adjusted HSI.

Table A-3. Mean nutria catch/1,000 acres of each marsh type, calculated nutria HSI values by marsh type, and adjusted HSI values by marsh type

Marsh Type	Mean Nutria Catch/1,000 acres	Calculated Nutria HSI value	Adjusted Nutria HSI value**
Fresh	512.7	1.00	0.80
Intermediate	284.9	0.56	0.45
Brackish	86.4	0.17	0.14
Saline	8.6*	0.02	0.02

* Palmisano (1973) did not report a value for a saline marsh; it was assumed that saline marsh is approximately 10% as productive as brackish marsh for nutria.

** all marsh types were assumed to be 20% below maximum value as nutria habitat; therefore, HSI values were multiplied by 0.8 to obtain adjusted HSI.

Muskrat - A preference index was calculated for each marsh type based on the survey conducted by Palmisano (1973) during November 1969 - December 1971. The values used are those determined for southeastern Louisiana. Table A-4 summarizes the values and calculations employed to arrive at a preference index.

Table A-4. Calculation of muskrat preference index for marsh type in southeastern Louisiana

(a) Marsh Type	(b) Mean No. of Muskrat houses observed Nov 1969 - Dec 1971	(c) % of total houses observed	(d) % of total habitat in survey	(e) Preference index*
Fresh	63	4.48	34.1	0.13
Intermediate	50	3.55	5.9	0.60
Brackish	1026	72.92	36.6	1.99
Saline	268	19.05	23.4	0.81
Total	1407	100.00	100.0	-

* Calculated by dividing column (c) by column (d) for each marsh type

To obtain muskrat HSI values, it was assumed that brackish marsh (preference index of 1.99) has an HSI of 1.0, and that muskrat HSI values for the remaining marsh types can be calculated by dividing the preference index of each marsh type by 1.99. It was also assumed that all marsh types are presently at 80 percent of full potential as muskrat habitat. This required reducing HSI values

by 20 percent. Table A-5 shows the calculated and adjusted muskrat HSI values for each marsh type.

Table A-5. Calculated and adjusted muskrat HSI values for marsh types in southeastern Louisiana

Marsh Type	Muskrat HSI	Adjusted Muskrat HSI*
Fresh	0.07	0.06
Intermediate	0.30	0.24
Brackish	1.00	0.80
Saline	0.41	0.33

* Calculated by multiplying HSI X 0.8; based on assumption that the four marsh types were 20% below full potential HSI for muskrat

Migratory Puddle Ducks - A preference index was calculated for puddle ducks using data for southeastern Louisiana reported in Palmisano (1973). The calculation of that index is shown in Table A-6.

Table A-6. Calculation of preference index for migratory puddle ducks in marsh types of southeastern Louisiana

(a) Marsh Type	(b) % of total Puddle Ducks recorded	(c) % of habitat sampled	(d) Preference index*
Fresh	65.04	32.02	2.03
Intermediate	8.04	7.59	1.06
Brackish	21.59	35.49	0.61
Saline	5.33	24.90	0.21

* Calculated by dividing column (b) by column (c).

The preference index for each marsh type was converted to an HSI. To accomplish this, fresh marsh (highest preference index at 2.03) was given an HSI of 1.0, and the HSI for other marsh types was calculated on basis of following formula:

$$\text{Migratory puddle duck HSI of specific marsh type} = \frac{\text{Preference type index of specific marsh}}{\text{2.03 (preference index for fresh marsh)}}$$

It was assumed that all marsh types are presently at 80 percent of full potential as migratory puddle duck habitat. Accordingly, migratory puddle duck HSI's were reduced by 20 percent. Table A-7 lists the calculated and adjusted migratory puddle duck HSI's for the various marsh types.

Table A-7. Calculated and adjusted migratory puddle duck HSI's for various marsh types in southeastern Louisiana

Marsh Type	Calculated Puddle Duck HSI	Adjusted Puddle Duck HSI*
Fresh	1.00	0.80
Intermediate	0.52	0.42
Brackish	0.30	0.24
Saline	0.10	0.08

* Represents 80% of calculated HSI

Alligators - It was assumed that the LWFC 1980 tag allotment by marsh types is a good index of each marsh type's alligator habitat quality. The 1980 tag allotments for Jefferson, St. Charles, Plaquemines, and St. Bernard Parishes were utilized, and are shown in Table A-8.

Table A-8. Average 1980 alligator tag allotments by marsh types for Jefferson St. Charles, Plaquemines, and St. Bernard Parishes

Marsh Type	Tag Allotment/Acres	Tag Allotment/1,000 Acres
Fresh	1/200	5.00
Intermediate	1/250	4.00
Brackish	1/275	3.64
Saline	0	0.00

To calculate alligator HSI's for each marsh type, it was assumed that fresh marsh (highest tag allotment/1,000 acres) has HSI of 1.00. Furthermore, it was assumed that the remaining marsh types have alligator HSI's on the following formula:

$$\text{HSI of specific marsh type} = \frac{\text{Tag allotment/1,000 acres of specific marsh type}}{\text{5.00 (Tag allotment for fresh marsh type)}}$$

It was also assumed that all marsh types are presently at 80 percent of their full potential as alligator habitat. This required downward adjustment of HSI's by 20 percent. Table A-9 displays calculated alligator HSI values for the four marsh types.

Table A-9. Calculated alligator HSI's by marsh types

Marsh Type	Alligator HSI	Adjusted Alligator HSI*
Fresh	1.00	0.80
Intermediate	0.80	0.64
Brackish	0.73	0.58
Saline	0.00	0.00

* Calculated by multiplying HSI x 0.8; this was based on assumption that the four marsh types are at 80% of full potential HSI for alligators

The calculated HSI's were assumed to remain unchanged for both FWOP and FWP conditions. Multiplying the HSI of a given marsh type for each evaluation element by the target year acreage was accomplished to derive an estimate of the number of HU's for each evaluation element, by target year. These values were then annualized to obtain an estimate of the Average Annual HU's (AAHU's) under FWOP and FWP conditions, and the net gain or loss in AAHU's attributable to the proposed freshwater introduction.

A problem existed in that the fresh and intermediate marsh types were combined into a fresh-intermediate category in the acreage projections developed by FWS and NODCE personnel, while the HSI calculations were based on relative abundance data reported separately for the fresh and intermediate marsh types. This was solved by first estimating the percentage of fresh-intermediate marsh comprised of fresh marsh and the percentage comprised of intermediate marsh. These values were then multiplied by the fresh-intermediate marsh acreage for a given target year to obtain an estimated breakdown of the acreage of fresh marsh and intermediate marsh present for that target year. Based on available information, it was assumed that fresh-intermediate marsh in Hydrologic Unit IV would be comprised of 57 percent fresh marsh and 43 percent intermediate marsh under existing, FWOP, and FWP conditions. For Hydrologic Unit IV, it was assumed that the fresh-intermediate marsh would be comprised of 100 percent intermediate marsh under existing and FWOP conditions. For FWP conditions, it was projected that intermediate marsh would make up 100 percent of the fresh-intermediate marsh category in 1985, changing to 90 percent intermediate/10 percent fresh by 1986, and 57 percent fresh/43 percent intermediate by 1995 and extending throughout the remainder of the project life (2035).

Table A-10 shows the net change in AAHUs in the area influenced by freshwater diversion via the Big Mar (Hydrologic Unit II) and the Davis Pond (Hydrologic Unit IV) diversion sites. In Hydrologic Unit II, puddle ducks will experience the greatest habitat gains, with an increase of nearly 39,900 AAHUs. Nutria and alligators will also be greatly benefitted, with increases of 35,400 and 29,800 AAHUs, respectively. The only species evaluated that will experience a decline in AAHUs is the muskrat. A net reduction of 18,900 AAHUs is forecast for that species; this decline is attributed to the conversion of brackish marsh to the

fresh and intermediate marsh types, which support comparatively lower muskrat populations. It should be pointed out that this analysis did not consider the probable increase in the quality of the remaining brackish marsh as muskrat habitat, attributable to increased nutrient inflow and anticipated increased production of muskrat food.

Table A-10. Comparison of Average Annual Habitat Units (AAHUs) under future without-project (FWOP) and future with-project (FWP) conditions in marshes influenced by freshwater diversions via Big Mar (Hydrologic Unit II) and Davis Pond (Hydrologic Unit IV) diversion sites

Evaluation Elements	Unit II AAHU-FWP	AAHU-FWOP	Change in AAHU	Unit IV AAHU-FWP	AAHU-FWOP	Change in AAHU
Alligator	104,603	74,765	+29,838	152,454	127,028	+25,426
Muskrat	85,551	100,457	-18,906	150,071	139,210	+10,861
Puddle Ducks	73,170	33,282	+39,888	115,108	94,036	+21,072
Nutria	55,767	20,325	+35,442	97,443	76,886	+20,556

In Hydrologic Unit IV, all of the species evaluated will experience gains with the proposed freshwater diversion. These gains include 25,400 AAHUs for alligators, 10,900 AAHUs for muskrat; 21,100 AAHUs for puddle ducks, and 20,600 AAHUs for nutria.

LITERATURE CITED

Palmisano, A. W. 1973. Habitat preference of waterfowl and fur animals in the northern Gulf Coast marshes. Pages 163-190 in R. H. Chabreck, ed. Proceedings of the coastal marsh and estuary management symposium. Louisiana State University Division of Continuing Education, Baton Rouge.

LOUISIANA

COASTAL AREA STUDY

APPENDIX B

MONETARY EVALUATION

OF

TENTATIVELY SELECTED PLAN

INTRODUCTION

This appendix summarizes the anticipated monetary effects of the tentatively recommended plan on sport and commercial fishing, sport hunting, and commercial fur and alligator harvest. These estimates are based primarily on differences in marsh acreages in Hydrologic Units II and IV expected to occur under future without-project (FWOP) versus future with-project (FWP) conditions (Tables B-1 and B-2).

EFFECTS ON FISHERIES

Sport

Project impacts on sport fishing were estimated by the Recreation Planning Section of the New Orleans District Corps of Engineers (NODCE), with some assistance from the Fish and Wildlife Service (FWS). The NODCE analysis combined freshwater fishing and saltwater fishing into a single category. A detailed explanation of the methodology used in that analysis is contained in Appendix G accompanying the feasibility report (FR) for this study. This analysis was based on the premise that sportfishing opportunity (supply), in terms of total man-days, is limited by access to the fishery. Another basic premise employed was that the dollar value of each man-day of sport fishing is a function of the quality of the experience which is, in turn, dependent on the available supply of sport fish. In other words, a man-day of fishing is assigned a higher value if the potential for a larger catch exists. As the available supply of sport fish was assumed to be correlated with acreage of total marsh, the greater total marsh acreage under FWP conditions equates to a greater dollar value per man-day of sportfishing. As shown in Table B-3, NODCE recreation specialists assumed that the total sportfishing effort will remain constant at 136,300 and 514,300 man-days per year in Units II and IV, respectively, over the project life (1985-2035) under both FWOP and FWP conditions. This assumption was made because access facilities (primarily the number of boat launching ramps) were determined by NODCE recreation specialists to be inadequate to meet present demand and were not projected to increase substantially during the project life. As shown in Table B-3, the average annual monetary value of sportfishing in Unit II is estimated at nearly $454,000 under FWOP conditions and approximately $490,000 under FWP conditions; this represents an annualized with-project increase of over $36,000. For Unit IV, sportfishing is projected to have an average annual value of nearly $1.5 million under FWOP conditions, and nearly $1.7 million under FWP conditions. Therefore, a net annualized increase of over $188,000 in the value of sportfishing has been attributed to the proposed freshwater introduction into Unit IV.

Commercial

<u>Freshwater</u> - Of the total commercial fishery landings attributable to the study area, less than one percent is comprised of freshwater

ble B-1. Comparison of future without-project (FWOP) and future with-project (FWP) acreages of fresh-intermediate, brackish, and saline marsh in Hydrologic Unit II (Breton Sound Basin), Louisiana Coastal Area

	Marsh Type (acres)			
rget Year	Fresh-Intermediate	Brackish	Saline	Total
78 (baseline)	13,595	131,257	46,766	191,618
85 FWOP	11,072	130,538	41,329	182,939
FWP	11,072	130,538	41,329	182,939
95 FWOP	8,258	128,318	34,641	171,217
FWP	76,889	105,042	0	181,931
05 FWOP	6,159	125,052	29,035	160,246
FWP	73,425	99,306	0	172,731
15 FWOP	4,593	121,051	24,335	149,979
FWP	70,115	93,883	0	163,998
25 FWOP	3,426	116,546	20,397	140,369
FWP	66,955	88,756	0	155,711
35 FWOP	2,555	111,724	17,096	131,375
FWP	63,938	83,909	0	147,847
nualized FWOP	5,850	122,420	27,524	155,794
FWP	64,978	98,842	4,133	167,953
Net Change	+59,128	-23,578	-23,391	+12,159

Table B-2. Comparison of future without-project (FWOP) and future with-project (FWP) acreages of fresh-intermediate, brackish, and saline marsh in Hydrologic Unit IV (Barataria Basin), Louisiana Coastal Area

	Marsh Type (acres)			
Target Year	Fresh-Intermediate	Brackish	Saline	Total
1978 (baseline)	196,647	111,661	157,489	465,797
1985 FWOP	164,002	114,422	152,059	430,483
FWP	164,002	114,422	152,059	430,483
1995 FWOP	124,538	113,465	144,625	384,628
FWP	138,454	116,065	146,648	401,167
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FWP	121,464	113,671	141,600	376,735
2015 FWOP	75,330	100,891	130,829	307,050
FWP	111,078	108,691	136,898	356,667
2025 FWOP	58,122	91,788	124,433	274,343
FWP	105,786	102,188	132,525	340,499
2035 FWOP	44,845	81,926	118,349	245,120
FWP	104,424	94,924	128,462	327,810
Annualized FWOP	92,409	102,558	134,529	329,496
FWP	122,199	109,058	139,586	370,843
Net Change	+29,790	+6,500	+5,057	+41,347

without-project (FWOP) and future with-project (FWP) conditions in Hydrologic Units II and IV, Louisiana Coastal Area

Target year	Unit II (Breton Sound)			Unit IV (Barataria Basin)		
	Use (man-days)	Value ($) per man-day	Total Value ($)	Use (man-days)	Value ($) per man-day	Total value ($)
1985 FWOP	136,331	3.90	531,691	514,349	3.77	1,939,096
FWP	136,331	3.90	531,691	514,349	3.77	1,939,096
1995 FWOP	136,331	3.65	497,608	514,349	3.36	1,728,213
FWP	136,331	3.90	531,691	514,349	3.53	1,815,652
2005 FWOP	136,331	3.44	468,979	514,349	3.03	1,558,477
FWP	136,331	3.69	503,061	514,349	3.32	1,707,639
2015 FWOP	136,331	3.20	436,259	514,349	2.71	1,393,886
FWP	136,331	3.53	481,248	514,349	3.16	1,625,343
2025 FWOP	136,331	2.99	407,630	514,349	2.42	1,244,725
FWP	136,331	3.32	452,619	514,349	2.99	1,537,904
2035 FWOP	136,331	2.83	385,817	514,349	2.17	1,116,137
FWP	136,331	3.16	430,806	514,349	2.87	1,476,182
Average annual FWOP	136,331	3.329	453,846	514,349	2.898	1,490,580
FWP	136,331	3.594	489,974	514,349	3.264	1,678,840
Net change	0	+0.265	+36,128	0	+0.366	+188,260

species; the remainder is made up of estuarine-dependent species. Therefore, no attempt was made to quantify project effects on freshwater commercial fisheries. A discussion of the potential qualitative impacts of the project on commercial freshwater fisheries is found in the main report.

Estuarine-Dependent - The importance of marshes to estuarine-dependent fisheries in coastal Louisiana cannot be over-emphasized. These marshes produce vast amounts of organic detritus which are transported into adjacent estuarine waters. The importance of plant detritus in estuarine food webs is well documented. Darnell (1961) concluded that detritus of vegetable origin seemed to be the single most important food material ingested by the fish and invertebrate consumers of Lake Pontchartrain. The contribution of vascular plant detritus to estuarine fisheries productivity was also documented by Odum et al. (1973). Marshes and associated shallow ponds and tidal creeks are also important as habitat for many estuarine-dependent species. Recent studies conducted within the upper Barataria Basin have substantiated the value of shallow marsh areas as nursery habitat for numerous estuarine-dependent species (Chambers 1980, Daud 1979, Rogers 1979, and Simoneaux 1979). Shallow marsh areas are also important as nursery grounds for brown shrimp and white shrimp in coastal Louisiana, according to studies conducted by biologists of the Louisiana Department of Wildlife and Fisheries (White and Boudreaux 1977). A three-year investigation of a low-salinity marsh area in the Galveston Bay System of southeastern Texas revealed that shallow marsh waters were prime habitat for immature shrimp (brown and white), gulf menhaden, Atlantic croaker, sand seatrout, and southern flounder (Conner and Truesdale 1973).

There is growing evidence that the acreage of marsh is the most important factor influencing the production of estuarine-dependent species of sport and commercial importance in the Gulf area. Turner (1979) reported that the Louisiana commercial inshore shrimp catch is directly proportional to the area of intertidal wetlands, and that the area of estuarine water does not seem to be directly associated with average shrimp yields. Lindall et al. (1972) presented evidence that shrimp and menhaden are being harvested at or near maximum sustainable yield. An analysis by Cavit (1979) of the dependence of menhaden catch on wetlands in coastal Louisiana suggested that menhaden yields are greatest in those hydrologic units having the highest ratio of marsh to open water. Harris (1973) has stated his opinion that total estuarine-dependent commercial fisheries production in coastal Louisiana has peaked and will decline in proportion to the acreage of marsh lost. Based on these considerations, it was assumed that the magnitude of future declines in marsh acreages (Tables B-1 and B-2) will determine future commercial estuarine-dependent finfish and shellfish yields. The calculation of commercial fishery benefits attributable to freshwater introduction was accomplished by NODCE Economics Branch personnel, with considerable assistance in the development of the methodology being provided by FWS, Louisiana Department of Wildlife and Fisheries (LDWF), and NODCE biologists. A

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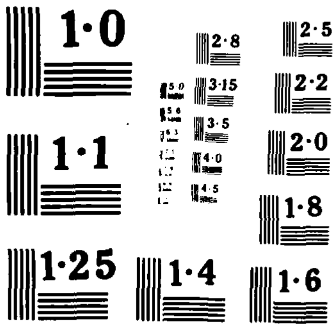
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detailed explanation of that methodology is contained in Appendix F accompanying the FR.

Table B-4 provides a comparison of the commercial harvest and value of shrimp, menhaden, and other estuarine-dependent finfishes and crustaceans under FWOP and FWP conditions in Hydrologic Units II and IV. As shown in that table, the proposed freshwater introduction into Unit II is expected to increase the average annual commercial shrimp harvest by 809,000 pounds having a net value (dockside value minus cost of harvest) of $185,000. Menhaden harvest in Unit II will experience an average annual with-project increase of 729,000 pounds, having an average annual net value of approximately $7,000. Under FWP conditions, the average annual harvest of other finfish and crustaceans (i.e., blue crab, Atlantic croaker, seatrout, spot, and red drum) in Unit II will increase by 177,000 pounds having a net value of $9,000. Under FWP conditions, commercial shrimp harvest in Unit IV is expected to experience an annualized increase of 3.8 million pounds having a net value of $855,000. Increases in annualized menhaden catch for that Unit under FWP conditions are estimated at 20 million pounds having a net value of $181,000. The commercial harvest of other estuarine-dependent finfishes and crustaceans in Unit IV is expected to increase, on an annualized basis, by 2.2 million pounds valued (net) at $92,000 annually, under FWP conditions. It is emphasized that the above increases are actually reductions in the rate of decline in commercial harvest expected under FWOP conditions. Commercial harvest of all of the species discussed above will decline under both FWOP and FWP conditions; the rate of decline will be smaller under FWP conditions.

An analysis of the impacts of the proposed freshwater introduction on commercial oyster harvest was also performed by the NODCE Economics Section, with assistance from NODCE, FWS, and LDWF biologists. Details regarding the methodology utilized are contained in Appendixes D and F in FR. It was assumed that, the proposed freshwater introduction would increase oyster harvest 100 percent over present levels by the year 1990, and remain at that level over the project life. This prediction was based on a review of reports by LDWF biologists (Pollard 1973, Dugas 1977), consultation with LDWF biologists having expertise in oyster biology, and prior projections of freshwater diversion benefits to oyster production (U.S. Fish and Wildlife Service 1959).

The proposed freshwater diversion will cause a seaward shift in the 15 parts per thousand (ppt) isohaline recommended by an *ad hoc* interagency group (Ford line). This seaward shift will help to reduce predation on oysters by the southern oyster drill, which commonly infests oyster grounds when salinities exceed 15 ppt and seriously reduces oyster production. Control of the southern oyster drill is the primary reason that the State of Louisiana has constructed and subsequently enlarged a freshwater diversion structure at Bayou Lamoque in southern Plaquemines Parish, and was a major justification for four unconstructed Federally-authorized diversion structures on the Mississippi River below New Orleans. The proposed freshwater diversion will also increase nutrient levels in the affected oyster growing areas, with an anticipated increase in populations of plankton

Table B-4. Projected commercial harvest and value of shrimp, menhaden, and other finfish and crustaceans under future without-project (FWOP) and future with-project (FWP) conditions in Hydrologic Units II and IV, Louisiana Coastal Area

	Harvest and Value (In Thousands)					
	Shrimp		Menhaden		Other a/	
Target year	lbs	$	lbs		lbs	
Unit II (Breton Sound)						
1985 FWOP	12,469	14,215	11,218	673	2,720	953
FWP	12,469	14,215	11,218	673	2,720	953
1995 FWOP	11,670	13,304	10,499	630	2,546	892
FWP	12,389	14,123	11,146	670	2,703	947
2005 FWOP	10,922	12,451	9,826	590	2,383	834
FWP	11,754	13,400	10,575	635	2,564	898
2015 FWOP	10,223	11,654	9,197	552	2,230	781
FWP	11,154	12,716	10,035	602	2,433	852
2025 FWOP	9,568	10,908	8,607	517	2,087	731
FWP	10,586	12,068	9,524	572	2,309	808
2035 FWOP	8,955	10,209	8,056	483	1,954	684
FWP	10,049	11,456	9,041	543	2,192	767
Average annual FWOP	10,619	12,106	9,553	573	2,316	811
FWP	11,428	13,029	10,282	617	2,493	873
Increase (gross)	809	923	729	44	177	62
Net value b/	-	185	-	7	-	9
Average annual equivalent value of net returns c/	-	130	-	5	-	7
Unit IV (Barataria Basin)						
1985 FWOP	39,058	44,526	208,690	12,523	22,872	6,360
FWP	39,058	44,526	208,690	12,523	22,872	6,360
1995 FWOP	34,897	39,782	186,460	11,189	20,435	5,682
FWP	36,398	41,494	194,478	11,670	21,314	5,928
2005 FWOP	31,180	35,545	166,598	9,997	18,258	5,078
FWP	34,181	38,966	182,634	10,959	20,016	5,566
2015 FWOP	27,859	31,759	148,852	8,932	16,314	4,537
FWP	32,360	36,890	172,905	10,375	18,950	5,269
2025 FWOP	24,891	28,376	132,996	7,981	14,576	4,054
FWP	30,893	35,218	165,062	9,905	18,091	5,030
2035 FWOP	22,240	25,354	118,829	7,131	13,023	3,621
FWP	29,742	33,906	158,916	9,536	17,417	4,843
Average annual FWOP	29,895	35,080	159,733	9,585	17,506	4,868
FWP	33,656	38,357	179,777	10,788	19,703	5,479
Increase (gross)	3,251	4,272	20,044	1,203	2,197	611
Net value b/		865	-	181		92
Average annual equivalent value of net returns c/	-	626		90	-	66

a/ Includes blue crab, Atlantic croaker, seatrout, spot, and red drum.
b/ Net value represents gross value minus cost of harvest.
c/ Average annual equivalent value calculated by New Orleans District Corps of Engineers Economics Branch at 8 1/8% discount rate.

consumed by oysters. The far greater nutrient content of Mississippi River water compared to that of adjacent estuaries unaffected by river discharge has been reported by Ho and Barrett (1975). Increased nutrient input into affected marsh areas will reduce marsh loss and increase plant growth. As a result, the production of organic detritus, utilized as food by oysters, is expected to be substantially higher under FWP conditions.

Table B-5 provides a comparison of anticipated oyster harvest over the period of analysis (1985-2035) under FWOP and FWP conditions. As shown in Table B-5, oyster harvest in Unit II is expected to decline from nearly 6 million pounds in 1985 to about 4.3 million pounds by the year 2035 under FWOP conditions. Under FWP conditions, oyster harvest is expected to increase to over 12.5 million pounds by the year 1990, and remain at that level through the year 2035. The oyster harvest in Unit II is expected to experience an average annual increase of 7.1 million pounds, having a net value of over $3.5 million, under FWP conditions. In Unit IV, oyster harvest under FWOP conditions is projected to decline from nearly 9.4 million pounds in 1985 to approximately 5.3 million pounds by the year 2035. With the proposed freshwater diversion, oyster harvest is projected to increase to nearly 20.3 million pounds by the year 1990 and remain at that level through 2035. The average annual increase in oyster harvest in Unit IV under FWP conditions is estimated to be nearly 12.6 million pounds having a net value of over $6.5 million. Table B-5 also shows the estimated reduction in the value of the oyster harvest in those areas where average salinities will be lowered below 5 ppt, considered the lower salinity limit for oyster production. The average annual equivalent value of oyster harvest from those areas, computed at an interest rate of 8 1/8 percent by NODCE economists, was subtracted from the average annual equivalent value of the FWP increase in net returns. The resulting adjusted average annual equivalent values were nearly $5.4 million for Unit II and nearly $8.8 million for Unit IV.

EFFECTS ON WILDLIFE

Sport Hunting

An analysis of project impacts on sport hunting use was conducted by the NODCE Recreation Planning Section. Data were provided to NODCE by FWS on such items as population densities of selected wildlife species by habitat type (Table B-6) and potential hunting effort (man-days), by species, for the various habitat types in the study area (Table B-7). NODCE recreation specialists used these data and information on acreages of specific habitat types within and adjacent to the study area to conduct an analysis of sport hunting supply, demand, and needs for the FWOP and FWP conditions.

Assumptions Made in Calculation of Wildlife Populations and Sport Hunting Potential (Man-days) Per Acre.

<u>Deer Hunting</u> - The value used for deer population density in fresh and intermediate marsh was 1 deer per 300 acres. This figure was provided by Bob Beter, Louisiana Department of Wildlife and Fisheries (LDWF) District Supervisor for District 8, New Orleans. The deer

Table B-5. Projected commercial harvest and value of oysters under future without-project (FWOP) and future with-project (FWP) conditions in Hydrologic Units II and IV, Louisiana Coastal Area

	Harvest and value (in thousands)			
	Unit II (Breton Sound)		Unit IV (Barataria Basin)	
Target year	Harvest (lbs)	Value ($)	Harvest (lbs)	Value ($)
1985 FWOP	5,977	9,324	9,363	14,606
FWP	5,977	9,324	9,363	14,606
1990 FWOP	5,782	9,020	8,580	13,385
FWP	12,520	15,274	20,260	24,717
1995 FWOP	5,594	8,727	8,366	13,051
FWP	12,520	15,274	20,260	24,717
2005 FWOP	5,235	8,167	7,475	11,661
FWP	12,520	15,274	20,260	24,717
2015 FWOP	4,900	7,644	6,678	10,418
FWP	12,520	15,274	20,260	24,717
2025 FWOP	4,586	7,154	5,967	9,308
FWP	12,520	15,274	20,260	24,717
2035 FWOP	4,292	6,696	5,331	8,316
FWP	12,520	15,274	20,260	24,717
Average annual				
FWOP	5,090	7,940	7,138	11,136
FWP	12,193	14,976	19,715	24,212
increase (gross)	7,103	7,036	12,577	13,076
net value a/	-	3,518	-	6,538
Average annual equivalent value of net returns b/	-	5,648	-	9,166
Loss of harvest from existing leases c/	-	232	-	383
Adjusted average annual equivalent value of increase in net returns	-	5,416	-	8,783

a/ Represents gross exvessel value minus cost of harvest.

b/ Average annual equivalent value calculated by NODCE Economics Branch, using 8 1/8 percent discount rate.

c/ Represents average annual equivalent value of loss of production due to excessive salinity reduction on existing leased oyster grounds.

Table B-6. Estimated population densities a/, by habitat type, of selected wildlife species in Louisiana Coastal Area

	Population Per Acre				
Species	Fresh/Int. Marsh	Brackish Marsh	Saline Marsh	Bottomland Hardwoods	Wooded Swamp
White-tailed deer	0.003	Neg.	Neg.	0.017	0.017
Squirrel	N/A	N/A	N/A	2.000	2.000
Swamp rabbit	0.500	0.400	0.100	0.500	0.500
Quail (Bobwhite)	N/A	N/A	N/A	0.010	Neg.
Mottled duck b/	0.012	0.005	0.0004	N/A	N/A

a/ Population data obtained from Louisiana Department of Wildlife and Fisheries.

b/ Mottled duck population estimates are for number of breeding pairs per acre, based on LDWF data, information reported in Bellrose (1976) and marsh acreage data in Chabreck (1972).

Table B-7. Potential sport hunting effort (man-days) per acre for selected wildlife species in Louisiana Coastal Area a/

	Potential Sport Hunting Effort (Man-days) Per Acre				
Species	Fresh/Int. Marsh	Brackish Marsh	Saline Marsh	Bottomland Hardwoods	Wooded Swamp
White-tailed deer	0.029	Neg.	Neg.	0.130	0.130
Squirrel	N/A	N/A	N/A	0.684	0.684
Swamp rabbit	0.164	0.131	0.033	0.164	0.164
Quail (Bobwhite)	N/A	N/A	N/A	0.004	Neg.
Waterfowl	0.488	0.383	0.018	0.016	0.053
Rails and snipe	0.188	0.188	0.250	Neg.	Neg.

a/ Assumptions regarding calculation of sport hunting potential are provided within the text of this Appendix.

population density value used for bottomland hardwoods (BLH) and wooded swamp (WS) was 1 deer per 60 acres. This figure was obtained from surveys conducted by the LDWF for those parishes in the study area. Deer populations are considered negligible in brackish and saline marshes. The sustained annual harvest rate used for deer was 33 percent, a commonly accepted figure among wildlife biologists. The hunter success rate (i.e., average number of days of hunting required to kill one deer) used in this analysis was 23.7 for BLH and WS habitats, and 26.5 for fresh and intermediate marshes. These values were derived from the LDWF deer kill survey (1980-81) season).

Rabbit Hunting - Population density values used for rabbits were 1 animal per 2 acres in BLH, WS, and fresh and intermediate marshes; 1 per 2.5 acres in brackish marsh; and 1 per 10 acres in saline marsh. These values were taken from LDWF surveys of parishes in the study area. The sustained annual harvest rate used for rabbits was 60 percent, a commonly accepted value. A hunter success rate of 0.547 was used for all habitat types, reported in the LDWF sate-wide 1977-78 small game survey, based on statistics for District 8.

Squirrel Hunting - Man-day use figures for squirrel hunting were determined only for BLH and WS habitats. A population density of 2 squirrels per acre was used, this value coming from the LDWF parish surveys. A sustained annual harvest rate of 60 percent was assumed. A hunter success rate of 0.570 was used; this was derived from the LDWF 1977-78 small game survey for the District 8 area.

Quail Hunting - Man-day use figures for quail were determined only for BLH habitat. LDWF parish surveys for the project area indicated a population density for 1 quail per 100 acres of BLH habitat. A sustained annual harvest rate of 60 percent of the quail population was used in analysis. The LDWF 1977-78 small game survey revealed a hunter success rate of 0.620 for quail hunting in the project area vicinity.

Waterfowl Hunting - Man-day values for migratory waterfowl hunting in fresh and intermediate marsh habitat were based on records for public waterfowl hunting on Lacassine and Sabine National Wildlife Refuges (1978-79 hunting season). Man-day values of 0.454 per acre for fresh marsh and 0.521 man-day per acre for intermediate marsh were utilized. These two values were then averaged, as the acreages for fresh and intermediate marsh were combined in the projection of habitat conditions. Man-day values for brackish and saline marsh were taken from the U.S. Fish and Wildlife Service (1980). For BLH habitats, a population density of one bird per 10 acres, a sustained annual harvest rate of 40 percent and a hunter success rate of 0.400 were used. These figures were taken from the U.S. Fish and Wildlife Service (1980) and Kennedy (1977).

Rail and Snipe - Man-day values for these species were taken from U.S. Army Corps of Engineers (1974). The values for fresh and intermediate marsh types were averaged to obtain the man-day value used for this project since the acreage figures for these two habitat types were combined.

The bulk of the acreage changes associated with the proposed freshwater diversion will occur in the three major types, i.e., fresh/intermediate, brackish and saline. Based on the acreage projections shown in Tables B-1 and B-2 and the data on wildlife population density displayed in Table B-6, estimates of populations of white-tailed deer, swamp rabbits, and mottled ducks expected to occur in the marshes of the study area at key target years were developed for FWOP and FWP conditions (Table B-8). As shown in Table B-8, the proposed diversion of fresh water into the marshes of Unit II will lead to an annualized (average annual) increase of 177 white-tailed deer; 17,800 swamp rabbits; and nearly 300 breeding pairs of mottled ducks. In Unit IV, the proposed freshwater introduction is expected to lead to an annualized increase of 90 white-tailed deer; 18,200 swamp rabbits; and 400 mottled duck breeding pairs in the affected marshes.

Estimates of sport hunting use (man-days) calculated by the NODCE Recreation Planning Section are shown in Table B-9. As shown in Table B-9, all types of sport hunting would be benefitted by the proposed freshwater diversion. For both Hydrologic Units II and IV, big game hunting would show the smallest average gains, while waterfowl hunting would experience the greatest net increase.

Commercial Wildlife

An estimate of increases in fur animal and alligator harvest associated with the tentatively selected plan was developed by the NODCE Economics Branch. These estimates relied heavily on data on average fur and alligator harvest by marsh type, provided by the FWS. Table B-10 displays average fur catch per acre by marsh type in coastal Louisiana, while Table B-11 shows the value of potential alligator harvest by marsh type in Hydrologic Units II and IV. Table B-12 displays the estimated value of commercial fur animal and alligator harvest in Hydrologic units II and IV. As shown in Table B-12, the net annualized increase in fur animal and alligator harvests attributable to the proposed freshwater introduction into Units II and IV is $234,000 and $175,000, respectively.

Table B-13 summarizes the average annual equivalent value of project benefits to sport fishing and hunting, commercial fisheries, and commercial wildlife harvest; these values were calculated by NODCE economists using a discount rate of 8 1/8 percent. As shown in Table B-13, freshwater introduction into Unit II will result in monetary benefits having an average annual equivalent value of over $6 million. Nearly 90 percent of this total is attributable to anticipated increases in oyster harvest, with the remainder attributable to sport fishing and hunting (5 percent), fur animal and alligator harvests (3 percent) and commercial finfish, shrimp and crab harvest (2 percent).

Net monetary benefits in Unit IV attributable to the proposed freshwater introduction will have an average annual equivalent value of nearly $9.7 million. As with Unit II, oyster benefits make up the bulk of this total ($8.8 million or 90 percent of total benefits). The remaining benefits are attributable to commercial finfish, shrimp

Table B-8. Populations of selected wildlife species expected to occur in the marshes of Hydrologic Units II and IV, Louisiana Coastal Area, at key target years a/

	Unit II (Breton Sound)			Unit IV (Barataria Basin)		
Target Year	Deer	Rabbit	Mottled Duck (pairs)	Deer	Rabbit	Mottled Duck (pairs)
1985 FWOP	33	64,884	803	492	142,976	2,601
FWP	33	64,884	803	492	142,976	2,601
1995 FWOP	25	58,920	755	374	122,118	2,120
FWP	231	80,462	1,448	415	130,318	2,301
2005 FWOP	19	56,005	711	293	105,959	1,769
FWP	220	76,435	1,378	364	120,360	2,083
2015 FWOP	14	53,151	670	226	91,104	1,461
FWP	210	72,611	1,310	333	112,705	1,932
2025 FWOP	10	50,371	632	174	78,220	1,207
FWP	201	68,980	1,248	317	107,021	1,833
2035 FWOP	8	47,678	597	135	67,028	995
FWP	192	65,533	1,187	313	103,028	1,780
Annualized FWOP	18	54,946	693	276	100,481	1,671
FWP	195	72,739	989	367	118,682	2,067
Net Change	+177	+17,793	+296	+91	+18,201	+396

a/ Assumptions regarding calculation of populations are discussed in text.

Table B-9. Projected sport hunting use (man-days) under future without-project (FWOP) and future with-project (FWP) conditions in marshes within Hydrologic Units II and IV, Louisiana Coastal Area

Target Year		Unit II (Breton Sound)				Unit IV (Barataria Basin)			
		Big game	Small game	Waterfowl	Other marsh birds	Big game	Small game	Waterfowl	Other marsh birds
1985	FWOP	321	20,280	56,143	36,956	4,756	46,903	126,594	90,358
	FWP	321	20,280	56,143	36,956	4,756	46,903	126,594	90,358
1995	FWOP	239	19,307	53,800	34,537	3,670	40,389	107,811	81,276
	FWP	2,230	26,371	77,753	34,203	4,015	42,750	114,659	84,511
2005	FWOP	179	18,350	51,424	31,927	2,831	34,761	91,664	73,137
	FWP	2,129	25,051	73,865	32,474	3,522	39,484	105,359	79,605
2015	FWOP	133	17,414	49,042	29,705	2,185	29,888	77,757	65,837
	FWP	2,033	23,798	70,173	30,833	3,221	36,974	98,299	75,593
2025	FWOP	99	16,503	46,676	27,654	1,686	25,662	65,759	59,291
	FWP	1,942	22,608	66,668	29,274	3,068	35,109	93,147	72,230
2035	FWOP	74	15,619	44,345	25,758	1,301	21,993	55,392	53,420
	FWP	1,854	21,478	63,339	27,795	3,028	33,800	89,627	69,594
Annualized									
	FWOP	170	17,905	50,237	30,996	2,680	33,030	86,797	70,286
	FWP	1,884	23,741	69,640	31,832	3,544	38,934	103,915	78,383
Net change		+1,714	+5,836	+19,403	+836	+864	+5,904	+17,118	+8,097

Table B-10. Fur catch and value by marsh type for coastal Louisiana

Species	Marsh Type Fresh-Intermediate	Brackish	Saline
Muskrat			
Average catch/acre a/	0.0880 b/	0.0844	0.0169 c/
Value/pelt d/	$5.70	$5.70	$5.70
Value/acre	$0.5015	$0.4811	$0.0963
Nutria			
Average catch/acre	0.3988 b/	0.0864	insignificant
Value/pelt	$7.76	$7.76	-
Value/acre	$3.0940	$0.6703	insignificant
Mink			
Average catch/acre	0.0015 b/	0.0011	insignificant
Value/pelt	$14.36	$14.36	-
Value/acre	$0.0215	$0.0158	insignificant
Otter			
Average catch/acre	0.0005 b/	0.0002	insignificant
Value/pelt	$46.80	$46.80	-
Value/acre	$0.0234	$0.0094	insignificant
Raccoon			
Average catch/acre	0.0093 e/	0.0078 f/	insignificant
Value/pelt	$12.03	$12.03	-
Value/acre	$0.1119	$0.0938	insignificant
Total			
Average catch/acre	0.4979	0.1799	0.0169
Gross value/acre	$3.75	$1.27	$0.0963
Net Value/acre g/	$2.82	$0.96	$0.07

a/ Average catch per acre, unless otherwise noted, from Palmisano (1973).

b/ Represents mean of fresh and intermediate marsh average harvest/acre reported by Palmisano (1973).

c/ Calculated as 25 percent of brackish marsh average harvest/acre reported by Palmisano (1973).

d/ Based on 1976-81 running average of prices received by the trapper, expressed in 1983 dollars using the Consumer Price Index for Hides,Skins, Leather and Related Products. Base price data compiled by Louisiana Department of Wildlife and Fisheries.

e/ Represents one half of the combined maximum production for fresh and intermediate marsh types reported by Palmisano (1973).

f/ Represents one half the maximum value reported by Palmisano (1973).

g/ Cost of harvest equals 25 percent of gross returns; net value equals gross returns minus cost of harvest.

Table B-11. Value of potential alligator harvest by marsh type in Hydrologic Units II and IV, Louisiana Coastal Area a/

	Marsh Type Fresh-Intermediate	Brackish	Saline
Mean harvest (hides/acre)			
Unit II (Breton Sound)	0.0050	0.0032	negligible
Unit IV (Barataria Basin)	0.0075	0.0038	"
Mean value/hide b/	$140.00	$140.00	N/A
Mean value of meat/animal c/	$75.21	$75.21	N/A
Mean total value/animal	$215.21	$215.21	N/A
Total value (gross/acre)			
Unit II	$1.08	$0.69	negligible
Unit IV	$1.61	$0.82	"
Net value (gross value less cost of harvest)/ acre) d/			
Unit II	$0.81	$0.52	negligible
Unit IV	$1.21	$0.62	"

a/ Data on hide value, mean hide length, mean weight, and harvest provided by Ted Joanen and David Richard, Louisiana Department of Wildlife and Fisheries, Grand Cheniere, Louisiana.

b/ Based on mean length/hide of 7 feet and mean 1983 hide price of $20.00 per linear foot.

c/ Based on mean dressed weight/animal of 47.6 pounds and estimated 1983 mean price of $1.58 per pound.

d/ Based on cost of harvest equal to 25 percent of total gross value.

Based upon its experience and decades of study and observation, this Department reiterates its support for the concept of controlled freshwater introduction primarily for the enhancement of fish and wildlife habitat and resources, and is interested and willing to cooperate in developing a program for the operation and monitoring of the diversion structures.

Sincerely yours,

J. Burton Angelle

J. Burton Angelle
Secretary

JBA/CJK/fsb

Exhibit A

15 ppt isohaline in an area in the lower end of the bay (commonly referred to as the "Ford Line"), conditions would be suitable for increasing oyster production many fold. An increase of 100% in oyster production or more under these conditions could then be a reasonable expectation, because such conditions would bring into a biologically productive zone the vast acreages of suitable oyster culturing bottoms which were developed in previous years of intensive culturing at the lower end of the bay. Additionally, the location of a diversion structure near the Davis Pond site would provide direct benefits to the Salvador Wildlife Management Area in the reduction of land loss rates in the area, enhancement of fish and wildlife production, and increased public hunting and fishing opportunities, while still accomplishing the overall benefits to Barataria Basin.

In Breton Sound the Department maintains an area for public seed grounds of some 600,000 acres. As in Barataria Bay, only a small portion of the area has been consistently productive in the past 20 years due to increasing salinity levels. If the proposed diversion structure at Big Mar is of sufficient size and functions as planned, Department biologists estimate that a considerable portion of the seed grounds could be restored to oyster production which could conceivably double present levels of production. In addition, the introduction of freshwater to the Breton Sound Basin would prove beneficial for other important species.

We anticipate that the diversion projects would provide overall benefits to fish and wildlife resources in Barataria and Breton Sound Basins as isohalines are moved seaward by freshwater introductions. However, in areas lying landward of the 5 ppt project isohaline, there would be some losses to oyster production. This would affect approximately 10,000 acres of leased waterbottoms in Barataria Basin and some 5,000 acres in the Breton Sound Basin. While the loss of potential production in these areas is a matter of great concern to the Department, we believe that with a lifting of the existing moratorium on new lease applications, lease holders who might be adversely affected would be provided opportunities to establish productive leases in other areas.

Another matter of concern is the impact of freshwater introduction during the spring months, especially during high river years, into areas utilized as brown shrimp nursery grounds. Introductions during this critical period could adversely affect the survival and growth of maturing brown shrimp in affected areas. Evaluations should be made to determine all feasible means by which such potential impacts to both oyster and shrimp production could be offset.

The Department is in agreement with the estimates for reduction of rates of marsh loss for various marsh types developed jointly by biologists for the Corps and Fish and Wildlife Service and that are cited in the report. While the Department recognizes the fact that the proposal under consideration would not completely reverse the trends of marsh loss, the diversions would reduce the rates of loss in the study area, and would aid significantly in maintaining a salinity regime more favorable to fish and wildlife production.

The Department has long recognized the value of freshwater introduction to the production of fish and wildlife resources. By the early '50's the Department and Plaquemines Parish were cooperating in the development of a site on the lower Mississippi River for the controlled introduction of freshwater into estuarine areas in the Parish. Since that time the successful operation of this freshwater diversion structure has been based upon a schedule of carefully controlled discharges and monitoring; excellent cooperation has existed between the Plaquemine Parish Council, the Louisiana Department of Health and Human Resources and the Louisiana Department of Wildlife and Fisheries. Our assessment of this project is that any adverse effects that may result from periodic introductions of Mississippi River water are greatly outweighed by the benefits of increased oyster production. Department biologists have indicated that oyster production has often doubled in these areas after large influxes of freshwater and such increases may be attributable, in large part, to more favorable salinity regimes which reduced predation and disease. The decreased salinities and subsequent increased oyster production in Breton Sound in 1974-76 were attributed to the openings of the Bonnet Carre Spillway in 1973 and 1975. After conducting a preliminary analysis of data collected in Lake Pontchartrain before and after the Bonnet Carre openings, Department biologists observed significant increases in many populations of estuarine-dependent species following the influx of large volumes of freshwater to the system.

The New Orleans Corps of Engineers in cooperation with various federal, state and local agencies, is now investigating the feasibility of enhancing habitat conditions and improving productivity of fish and wildlife resources by the introduction of freshwater into two estuaries, Barataria Bay and Breton Sound, and adjacent wetlands. These areas now support extensive commercial and sport fisheries, and are important hunting and trapping areas, and like much of coastal Louisiana, have experienced the adverse effects of saltwater intrusion and land loss in recent years. This is indicated by the reduction of fresh and intermediate marsh, the concomitant expansion of saline and brackish marsh, and the conversion of large acreages of marsh to open water. Two diversion sites are now being evaluated. One for the Barataria Basin would be located near Davis Pond (river mile 118) below the community of Lone Star at which Mississippi River water would be routed into the Department owned Salvador Wildlife Management Area. The other would be located at Big Mar and would provide for a diversion of water to the Breton Sound Basin.

It becomes very evident when oyster production records for the Barataria unit are examined, that the prime oyster seed and culturing grounds have shifted significantly northward through the bay. During periods of low rainfall, low river stages and decreased freshwater influx, as was experienced during the latter part of 1981 and early 1982, very limited oyster production takes place in Barataria Bay proper because salinity levels are too high for successful production to occur. This bay, particularly the lower end, was historically a prime area for the production of oysters and has extensive areas with suitable bottoms. With proper control of the diversion structure and the introduction of controlled amounts of freshwater adequate to maintain the average position of the

State of Louisiana

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EDWIN W EDWARDS
GOVERNOR

September 10, 1984

Colonel Eugene S. Witherspoon
District Engineer
New Orleans District, Corps of Engineers
P. O. Box 60267
New Orleans, Louisiana 70160-0267

Dear Sir:

On July 2, 1982 the Department of Wildlife and Fisheries provided comments relative to the interim report on proposed freshwater diversions to Barataria and Breton Sound Basins. The comments contained herein are intended to address the proposal in general, and more specifically, to evaluate revisions to the original report which concern a new tentatively selected plan for Barataria Basin.

Because of its extensive coastal wetlands, Louisiana is the nation's leader in commercial fisheries production, and alligator and wild fur harvests; Louisiana also supports significant recreational economies based upon sport fishing and hunting for waterfowl and game animals.

However, it is now well documented that Louisiana's coastal areas are subsiding and eroding and some investigators have estimated a coastwide land loss rate from all causes as high as 45 square miles a year.

The state's coastal marshes and estuaries provide habitats and nursery areas for a wide variety of fish and shellfish species and marsh vegetation provides a source of organic material which is an important component of the detrital based food web. Recent scientific studies tend to substantiate the view that the production of commercial and recreational fisheries is linked not only to the quality of marsh habitat but to the quantity of habitat as well. For example, some researchers have reported that Louisiana commercial shrimp catches are directly proportional to the area of intertidal wetlands. The National Marine Fisheries Service has stated that the total estuarine-dependent commercial fisheries production of coastal Louisiana, including menhaden, shrimp, oysters, crabs, and some industrial bottomfish, has probably reached a peak and will decline in proportion to the acreages of marshland lost. Wildlife biologists would likewise agree that the production of furbearers, alligators, waterfowl, and game animals is linked in a similar way to the wetlands.

Exhibit A

interested and willing to cooperate in developing a program for the operation and monitoring of the diversion structures.

Sincerely,

Jesse J. Guidry

Jesse J. Guidry
Secretary

JJG/CJK/fs

Exhibit A

It becomes very evident if one looks in depth at the oyster production records for the Barataria unit, that the prime oyster seed and culturing grounds have shifted significantly northward through the bay (Van Sickle, 1981). During periods of low rainfall, low river stages and decreased freshwater influx, as was experienced during the latter part of 1981 and early 1982, very limited oyster production takes place in Barataria Bay proper because salinity levels are too high for successful production to occur. This bay, particularly the lower end, was historically a prime area for the production of oysters and has extensive areas with suitable bottoms. With proper control of the diversion structure and the introduction of freshwater adequate to maintain the average position of the 15 ppt isohaline in an area in the lower end of the bay (commonly referred to as the "Ford Line"), conditions would be suitable for increasing oyster production many fold. An increase of 100% in oyster production or more under these conditions could then be a reasonable expectation, particularly when one visualizes that such conditions would bring into a biologically productive zone the vast acreages of suitable oyster culturing bottoms which were developed in previous years of intensive culturing at the lower end of the bay.

In addition, the location of a diversion structure near the Davis Pond site would provide direct benefits to the Salvador Wildlife Management Area in the reduction of land loss rates in the area, enhancement of fish and wildlife production, and increased public hunting and fishing opportunities, while still accomplishing the overall benefits to Barataria Basin.

In Breton Sound the Department maintains an oyster seed ground reservation of some 600,000 acres. As in Barataria Bay, only a small portion of the area has been consistently productive in the past 20 years due to increasing salinity levels. If the proposed diversion structure at Big Mar is of sufficient size and functions as planned, Department biologists estimate that a considerable portion of the reservation could be restored to oyster production which could easily double present levels of production. In addition, the introduction of freshwater to the Breton Sound Basin would prove beneficial for other commercially important forms.

The Department is in agreement with the estimates for reduction of rates of marsh loss for various marsh types developed jointly by biologists for the Corps and Fish and Wildlife Services and that are cited in the report. While the Department recognizes the fact that the proposal under consideration would not completely reverse the trends of marsh loss, the diversions would reduce the rates of loss in the study area, and would aid significantly in maintaining a salinity regime more favorable to fish and wildlife production.

Based upon its experience and decades of study and observation, this Department reiterates its support for the concept of controlled freshwater introduction primarily for the enhancement of fish and wildlife habitat and resources, and is

Service has stated that the total estuarine dependent commercial fisheries production of coastal Louisiana, including menhaden, shrimp, oysters, crabs, and some industrial bottomfish, has probably reached a peak and will decline in proportion to the acreages of marshland lost. Wildlife biologists would likewise agree that the production of furbearers, alligators, waterfowl, and game animals is linked in a similar way to the wetlands.

The Department has long recognized the value of freshwater introduction to the production of fish and wildlife resources. In the early 1950's and 1970's, in cooperation with the Plaquemines Parish Council, the Department contributed monies and technical assistance for the development of two sites, Bayou Lamoque (as a demonstrational project) and Bohemia on the lower Mississippi River, for the controlled introduction of freshwater into estuarine areas of Plaquemines Parish. These projects also involved monitoring and enforcement by closing contaminated areas to oyster harvests by the Louisiana Department of Health and Human Resources. Since that time the successful operation of these two freshwater diversion structures has been based upon a schedule of carefully controlled discharges and monitoring with excellent cooperation between the parish council, and the Departments of Health and Human Resources and Wildlife and Fisheries. Our assessment of these projects is that any adverse effects that may result from periodic introductions of lower quality Mississippi River water are greatly outweighed by the benefits of increased productivity. Ron Dugas (oyster biologist with the Department) indicated that oyster production has often doubled in these areas after large influxes of freshwater and that may be attributable, in large part, to more favorable salinity regimes which reduced predation and disease. The decreased salinities and subsequent increased oyster production in Breton Sound in 1974-76 were likely due to the openings of the Bonnet Carre spillway in 1973 and 1975. After conducting a preliminary analysis of data collected in Lake Pontchartrain before and after the Bonnet Carre openings, Johnny Tarver (Department biologist) observed significant increases in many populations of estuarine dependent species following the influx of large volumes of freshwater to the system.

The New Orleans Corps of Engineers in cooperation with this agency, NMFS, and the U. S. Fish and Wildlife Service, is now investigating the feasibility of enhancing habitat conditions and improving productivity of fish and wildlife resources by the introduction of freshwater into two estuaries, Barataria Bay and Breton Sound, and adjacent wetlands. These areas now support extensive commercial and sport fisheries, and contain important hunting and trapping areas, and like much of coastal Louisiana, have experienced the adverse effects of saltwater intrusion and land loss in recent years as indicated by the reduction of fresh and intermediate marsh, the concomitant expansion of saline and brackish marsh, and the conversion of large acreages of marsh to open water. Two diversion sites are now being evaluated. One for the Barataria Basin would be located near Davis Pond (river mile 118) below the community of Lone Star at which Mississippi River water would be routed into the Department owned Salvador Wildlife Management Area. The other would be located at Big Mar and would provide for a diversion of water to the Breton Sound Basin.

State of Louisiana

DEPARTMENT OF WILDLIFE AND FISHERIES

JESSE J. GUIDRY

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DAVID C. TREEN

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January 28, 1983

Colonel Robert C. Lee, District Engineer
New Orleans District, Corps of Engineers
P. O. Box 60267
New Orleans, Louisiana 70160

Dear Sir:

On July 2, 1982 the Department of Wildlife and Fisheries provided comments relative to the interim report on proposed freshwater diversions to Barataria and Breton Sound Basins. The comments contained herein are intended to supplement the Department's initial review of the report, and to further develop some of the conceptual aspects of the proposal.

Louisiana's coastal wetlands support the nation's largest commercial fishery, alligator and wild fur harvests as well as significant recreational economies based upon sport fishing and hunting for waterfowl and game animals. It is now well documented, however, that Louisiana's coastal regions are subsiding and eroding, and some researchers have estimated a coastwide land loss rate as high as 49 square miles a year (Bauman, personal communication).

At the time when the Mississippi and Atchafalaya River systems were leveed off, the effects of severely restricting the processes of overbank flooding and distributary flow were not well known. Today it is generally understood that the discharge of nutrient and sediment-rich freshwater from the Atchafalaya and Mississippi Rivers, in concert with man-induced processes, has played a major part in controlling the rate of marshland gains or losses in Louisiana coastal areas.

The coastal marshes and estuaries provide habitat and nursery areas for a variety of fish and shellfish species. Marsh vegetation provides a source of organic material which is an important component of the detrital based food web. Recent studies tend to substantiate the view, held by most investigators, that the production of commercial and recreational fisheries is linked not only to the quality of marsh habitat but to the quantity of habitat as well. For example Turner (1977) reported that Louisiana commercial shrimp catches are directly proportional to the area of intertidal wetlands. The National Marine Fisheries

Exhibit A

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and crab harvest (6 percent), sport fishing and hunting (3 percent) and commercial fur animal and alligator harvest (1 percent).

Table B-13. Summary of average annual monetar benefits a/ to sport fishing and hunting, commercial fisheries, and commercial fur animal and alligator harvests in Hydrologic Units II and IV, Louisiana Coastal Area

	(thousands of dollars)		
	Avg. annual FWOP	Avg. annual FWP	Increase
Unit II (Breton Sound)			
Sport fishing and hunting	1,506	1,817	311
Commercial fisheries			
shrimp	2,627	2,757	130
menhaden	93	98	5
oysters	2,651	8,067	5,416
other	132	139	7
total	5,503	11,061	5,558
Commercial fur animal and alligator harvest	218	403	185
Unit II total	7,227	13,281	6,054
Unit IV (Barataria Basin)			
Sport fishing and hunting	3,814	4,073	259
Commercial fisheries			
shrimp	7,807	8,233	426
menhaden	1,647	1,737	90
oysters	3,941	12,724	8,783
other	836	882	46
total	14,231	23,576	9,345
Commercial fur animal and alligator harvest	679	785	106
Unit IV total	18,724	28,434	9,710

a/ Represents average annual equivalent value, calculated by New Orleans District Corps of Engineers Economics Branch at 8 1/8% discount rate.

Table B-12. Net value a/ of commercial wildlife harvest under future without-project (FWOP) and future with-project (FWP) conditions in Hydrologic Units II and IV, Louisiana Coastal Area

(thousands of dollars)

Target Year		Unit II (Breton Sound)			Unit IV (Barataria Basin)	
	Fur animals	Alligators	Total	Fur animals	Alligators	Total
1985 FWOP	158	77	235	582	268	850
FWP	158	77	235	582	268	850
1995 FWOP	148	73	221	474	222	696
FWP	311	189	500	512	296	808
2005 FWOP	138	70	208	389	184	573
FWP	296	180	476	461	268	729
2015 FWOP	130	66	196	318	152	470
FWP	283	172	455	426	248	674
2025 FWOP	122	63	185	260	126	386
FWP	268	162	430	404	236	640
2035 FWOP	114	60	174	213	104	317
FWP	256	155	411	394	229	623
Average annual net returns FWOP	135	68	203	368	174	542
FWP	273	164	437	458	259	717
Increase	138	96	234	90	85	175
Average annual equivalent value of net returns b/	-	-	185	-	-	106

a/ Net value represents gross value minus cost of harvest; cost of harvest is 25% of gross price paid to trapper.

b/ Average annual equivalent value calculated by New Orleans District Corps of Engineers Economics Branch at 8 1/8% discount rate.

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